

Transmitted Via U.S. Federal Express

April 13, 2000

Mr. David Slowick
Massachusetts Department of Environmental Protection
436 Dwight Street
Springfield, MA 01103

Re: Massachusetts Contingency Plan Release Abatement Measure (RAM) Plan
Former Gas Holder Area RTN 1-11901
Solutia Inc., Springfield, MA
BBL Project #: 0102.10258/1164.07418 #2.04

Dear Mr. Slowick:

On behalf of Solutia Inc. (Solutia), Blasland, Bouck & Lee Inc. (BBL) presents a Massachusetts Contingency Plan (MCP), 310 Code of Massachusetts Regulation (CMR) 40.0000 Release Abatement Measure (RAM) Plan for the Former Gas Holder Area (RTN 1-11901). The Former Gas Holder Area is a Tier II classified site at the Indian Orchard Plant in Springfield, Massachusetts. The general objectives of the RAM Plan are to:

- Remediate subsurface soil of vinyl chloride (VC) in-situ;
- Reduce potential for VC to leach to ground water;
- Confirm single source of VC; and
- Provide data to demonstrate natural attenuation (NA) of VC and ethylbenzene in ground water.

This RAM Plan is organized into the following four headings:

- Background;
- Soil Remediation Plan;
- Ground-Water Natural Attenuation Monitoring Plan; and
- Schedule.

Background

Site History

The Former Gas Holder Area is located on the Solutia Property near a former aboveground process vessel ("gas holder") that recycled VC (Figure 1). VC was used in the "gas holder" tank in the southern portion of the site at former Building 85 during polyvinyl chloride (PVC) manufacturing from 1946 to 1975. Volatile organic compounds (VOCs) consisting primarily of VC, exist in a layer of fine, white, granular material approximately 5 to 6 feet below ground surface with an area of approximately 30 feet by 45 feet. The source of the VC detected in soil and ground water is likely associated with the vapor condensation "gas holder" tank, which contained residual and partially polymerized PVC. The white material (confirmed to be off-specification standard grade PVC or partially polymerized PVC [Attachment 1]) exhibits concentrations of VC up to 698 mg/kg above MCP upper concentration limits (UCLs) with lesser



concentrations of trichloroethene (TCE), 1-2 dichloroethene (DCE), and 1-2 dichloroethane (DCA) detected above MCP reportable concentrations but below UCLs. Ground-water flow direction at the Former Gas Holder Area site is toward the southwest. The dissolved VC plume in ground water has been defined and does not extend off site or to surface water bodies.

A bench scale study was conducted to evaluate the treatability of the white material (Attachment 1). The results of the bench scale treatability study demonstrate that a chemical oxidant (sodium permanganate) was effective in the laboratory at destructing chlorinated hydrocarbons to concentrations less than method detection limits. In accordance with Solutia's notification letter to the Massachusetts Department of Environmental Protection (MADEP) dated July 27, 1999, a pilot test using the sodium permanganate oxidant was conducted at the VC source area to evaluate the efficiency of an in-situ application of the oxidant. Based on the results of this pilot study, the in-situ application of sodium permanganate oxidant via multiple injection points was effective in reducing VC concentrations to at least four orders of magnitude below the pre-treatment concentration (from approximately 500 mg/kg to approximately 0.2 mg/kg). The pilot study report is presented in Attachment 2.

On February 4, 2000, an MCP Phase II Comprehensive Site Assessment (CSA) Report was submitted for the Former Gas Holder Area (RTN – 1-11901) five months ahead of the July 7, 2000 compliance schedule. This report was entitled "MCP Phase II Comprehensive Site Assessment Report for RTNs 1-10793, 1-10868, 1-10869, 1-11692, 1-11693, 1-11694, and 1-11901 Investigation Areas, Volumes I and II, February 2000," prepared for Nova Chemicals Inc. and Solutia Inc., Springfield, Massachusetts, by BBL and referred to herein as the Phase II CSA Report.

Provided below is a summary of outcomes from the Phase II CSA Report.

Area Identification	Phase II Outcome and Compliance Activities
Former Gas Holder Area	- An imminent hazard does not exist. - Soil remediation is required. Based on a pilot study, Solutia plans to remediate the soils using a chemical oxidant (Chem-Ox) remedial additive. A RAM Plan will be prepared and implemented before the July 7, 2000 Phase III due date. - A monitored natural attenuation program will be implemented for VC and ethylbenzene in ground water with VC source control measures via Chem-Ox. - A Class A-3 Response Action Outcome (RAO) may be achieved, upon reducing VC concentrations in soils below UCLs and completing a ground-water monitoring program, assuming an industrial land use Activity Use Limitation (AUL). - Solutia plans to complete an AUL, implement the RAM, and complete the second round of NA monitoring before the July 7, 2000 Phase III due date.

Compliance History

The following table identifies the compliance history and status for the Former Gas Holder Area (RTN 1-11901).

Area Name	Compliance History			Planned Compliance Activities Outcome*
	Notification Type/Date	Tier Class and Date	Phase II and Phase III Report Due Date/Status*	
Former Gas Holder Area (RTN 1-11901)	120-day June 30, 1997	Tier II July 1998	- MCP Phase II Report submittal, February 4, 2000 - MCP Phase III Report date, July 7, 2000 (<i>Solutia plans to remediate via RAM and RAO prior to Phase III due date.</i>)	- <i>Remediation of soils before July 7, 2000.</i> - <i>AUL before July 7, 2000.</i> - <i>Continue ground-water monitoring after RAO.</i>

Note: Outstanding items shown in italics.

* Date based on date of MADEP notice of responsibility letter for RTN 1-11901, July 7, 1997.

Summary of RAM Objectives

A RAM is being conducted following the completion of an MCP Phase II CSA Report submitted February 4, 2000, for the Former Gas Holder Area (RTN 1-11901). The RAM involves the introduction of a chemical oxidant as a remedial additive (sodium permanganate oxidant) to the vinyl chloride source (off-grade PVC) within the subsurface soils. The off-grade PVC is found to contain vinyl chloride (at concentrations above UCLs for soils), which is leaching to ground water at concentrations below UCLs but above MCP reportable concentrations. The specific objectives of this RAM are to:

- Degrade VC average concentration below UCLs as part of an MCP Permanent Solution (RAO) within the source area materials;
- Mitigate potential for leaching to ground water;
- Confirm that a single source is responsible for the concentrations in ground water near MW-93A; and
- Demonstrate the adequacy of natural attenuation (NA) mechanisms in ground water in support of a monitored NA remedy, which is part of an MCP Permanent Solution (RAO) downgradient of the source area.

Applicability to RAM [310 CMR 40.0442]

The remedial technology selected for the Former Gas Holder Area (RTN 1-11901) is applicable to a RAM because the remedial addition is simple, limited in scope, and is being applied on a relatively small scale. The technology is simple and the field installation is comparable to that of an air sparging system in that multiple, closely-spaced injection points are used. However, it is simpler and safer than air sparging because there is no potential for off-gas discharge and treatment. A remedial additive (sodium permanganate oxidant) is used as an oxygen source for the degradation of vinyl chloride, as opposed to air or pure oxygen.

The selected remedial technology is limited in scope based on a pilot study, and we anticipate that a single application of sodium permanganate oxidant (over a 10-day period) will be required to achieve the objectives of the additive.

The size of the project is small. Approximately 1,500 square feet (or 55 cubic yards) of soils are anticipated for treatment.

The sodium permanganate oxidant as a solid contains sodium, potassium, and manganese and trace inorganic elements below the most stringent reportable concentrations for soils. Further details on the typical composition of the sodium permanganate oxidant is presented in Attachment 3.

The injection of the sodium permanganate oxidant would not result in the exposure of workers to the source material because the treatment is conducted in-situ. The sodium permanganate oxidant is not anticipated to impede future remedial actions, which include the natural attenuation of VC in ground water downgradient of the source area.

Given the limited depth and volume of source material, other remedial approaches were evaluated for this RAM. Excavation was considered but was ruled out because of the following complications:

- Physical hazard potential during excavation in active process area of the plant to excavation workers and general plant workers;
- Physical damage potential to existing structures, (building foundations, process area foundations, underground and aboveground utilities);
- Chemical exposure hazards of excavation workers and general plant workers during excavation and stockpiling for disposal;
- Handling, treatment, and disposal permitting of ground water during dewatering for excavation; and
- Handling, treatment, and/or disposal of soil following excavation.

Engineered barriers were also considered and could be selected as a remedial contingency. An engineered barrier could provide source control from leaching to the ground water, but material above the MCP UCLs would still remain in the subsurface.

Data Supporting Effectiveness of Sodium Permanganate Oxidant Injection

A bench scale study (Attachment 1) and a pilot study report (Attachment 2) present the data that support the effectiveness of the sodium permanganate oxidant injection to remedial soils. The site characterization data support is presented in the MCP Phase II CSA Report submitted for the Former Gas Holder Area (RTN 1-11901) in February 2000. Based on the Phase II CSA Report, the horizontal and vertical extent of the source material has been evaluated and delineated.

Based on the Phase II CSA, the ground-water flow direction has been evaluated (Figure 3-6 of the Phase II CSA Report), the underground utilities have been mapped, and the extent of dissolved vinyl chloride in ground water has been delineated (Figure 6-3 of the Phase II CSA Report). Based on this delineation, no complete migration pathway to surface water/sediments has been identified, and the dissolved phase plume does not appear to migrate off site (Figure 3-6 of the Phase II CSA Report). Potential for indoor air concentrations were modeled based on the observed ground-water concentrations, using both MADEP Method 3 Risk Characterization and United States Environmental Protection Agency (USEPA) procedures. Potential indoor air values were below risk values (Section 7.3 and 7.8 of the Phase II CSA Report) based on the data available at the time of the report.

A pilot study and an evaluation of the soil properties (including hydraulic conductivity, porosity, and grain size) have been completed for the design of the sodium permanganate oxidant injection system (Attachment 2 and Section 3 of the Phase II CSA Report).

The RAM will be conducted consistent with current professional performance standards (MCP 310 CMR 40.0191), with General Provisions for the Management of Remedial Additives (MCP 310 CMR 40.0041) and with Reporting Requirements for Discharges of Remedial Additives (MCP 310 CMR 40.0047). During RAM implementation, the Draft Remedial Monitoring Transmittal Form (Attachment 4) will be completed daily.

Soil Remediation Plan

- Objective

The objective of the Soil Remediation is to reduce average VC concentrations in soil below UCLs in-situ and to mitigate the potential for VC to leach to ground water. The objective of this RAM will also be to confirm the limited extent of the VC and to confirm that there are no additional VC sources to ground water.

- Scope of Work

The Scope of Work for the Soil Remediation portion of the RAM Plan will consist of the following tasks:

- Task 1 – Utility Clearance;
- Task 2 – Injection Well Installation;
- Task 3 – Sodium Permanganate Oxidant Injection and Monitoring;
- Task 4 – Post Injection Monitoring;
- Task 5 – Confirmatory Sampling and Analysis;
- Task 6 – Supplemental Soil Investigation; and
- Task 7 – Report.

Task 1 - Utility Clearance

The utilities will be cleared at each area subject to drilling per Solutia's requirements, using the procedures in Attachment 5. The Massachusetts utility service, "Dig Safe," will be called at least 72 hours prior to drilling. The available utility maps will be assembled for each area subject to drilling. A private utility locator will also be used to verify the approximate depth and location of water, sewer, electric, telephone, and gas utilities.

Task 2 - Injection Well Installation

The approximate injection area is shown on Figure 2, based on previous data from a 10-foot soil boring grid program. The actual area to be remediated will be delineated during the installation of the injection well network. The injection points will be installed in a radial pattern with a spacing of 8-foot centers, beginning in the center of the area known to contain white material (Figure 2). All areas found to contain the white material will be considered impacted and subjected to remediation.

Injection points will be installed using an AMS direct push rig. They will be constructed of one-inch-diameter Schedule-40 PVC with an approximately six-inch-long 0.010-inch slot screen, and completed with six-inch-diameter flush-mounted road boxes. The screen interval of the injection point will be the same length as the thickness of the white material, and the riser of the injection point will be installed at the top of the white material. The injection points will be installed consistent with Standard References for Monitoring Wells Supplemental (DEP Publication WSC-310-91).

Task 3 – Sodium Permanganate Oxidant Injection and Monitoring

Sodium permanganate oxidant will be injected through the array of injection points throughout the treatment area in a dilute 1 percent solution (34 gallons per Liter [g/L]).

The 1 percent sodium permanganate oxidant solution will be prepared on site in 600-gallon batches using a portable (i.e., trailer-mounted) chemical oxidant injection system (PCOIS). A schematic of the PCOIS is presented on Attachment 6. The system consists of:

- One 800-gallon high density polyethylene chemical batch tank equipped with a secondary containment system;

- One chemical transfer pump (to transfer concentrated chemical oxidant from the 55-gallon drum to the batch tank);
- Six chemical metering pumps (to pump diluted chemical oxidant from the batch tank to injection points);
- One Schedule-80 PVC manifold (to distribute diluted chemical oxidant to injection points) equipped with by-pass valves and pressure gauges;
- Six Schedule-80 PVC injection well head assemblies;
- Reinforced PVC tubing (to connect PVC manifold to injection well head);
- Miscellaneous Schedule-80 PVC fittings (unions, barbed fittings, etc.); and
- Gas-powered generator equipped with emergency shut-off switch (to run metering pumps).

Each batch of dilute chemical oxidant will be injected simultaneously through six injection points (167 gallons per well) over the course of a day (i.e., injection rate of approximately 0.5 gallons per minute). It is estimated that injection of the sodium permanganate oxidant solution will be completed over a one- to two-week period, depending on the final number of injection points.

To meet the requirements of 310 CMR 40.0045 (1) Requirement for All Discharges to the Ground Surface or Subsurface and/or Ground Water, the rate of injection will be 0.5 gallons per minute to eliminate the potential for:

- Surficial erosion and/or flooding;
- Diversion of remedial additive into utilities; or
- Mounding of the water table to within two feet of ground surface.

(Note: Because there are no basements in the nearby buildings housing process equipment, there is little potential for remedial additive migration into buildings. One building 100 feet hydraulically upgradient on NOVA property will be checked, if accessible.)

Permit Requirements

Applicable federal, state, and local permit requirements were evaluated, and it was determined that:

- No local building permits required because no structures will be constructed;
- An Off-Gas Treatment of Point-Source Remedial Air Emissions permit is not required because off-gases will not be generated from the sodium permanganate oxidant injection;
- A Massachusetts Ground Water Discharge Permit will not be required because the RAM introduction of a remedial additive will be conducted per the MCP 310 CMR 40.0041 through 40.0047;
- A local conservation commission, state Wetlands Protection Act, or federal wetlands permit will not be required because the nearest water body (Chicopee River) is 400 feet from the source area and there is no wetland vegetation at or within 100 feet of the Former Gas Holder Area; and
- A state or federal discharge to surface water permit will not be required because there will be no discharges to surface water as a result of this RAM.

Preventative Measures

Concentrated sodium permanganate oxidant will be stored out of direct sunlight in Building 81 in a 55-gallon drum (as shipped) per the manufacturer's Material Safety Data Sheet (MSDS) fact sheet (Attachment 3).

The PCOIS will be constructed with a secondary containment system to contain potential leaks, if any, from the PCOIS. The nearby storm drains will be covered during injection activities to prevent migration of oxidant in the event of a catastrophic release.

The nearby storm drains (Figure 2) will also be monitored before and during chemical oxidant injection to ensure there is no unintended migration of the oxidant into the local drainage system (see "Monitoring Activities" below). The storm drains will be monitored in the field by measuring temperature, conductivity, and pH (using a water quality meter) and testing for the presence of sodium permanganate oxidant (using a colorimeter).

Monitoring Activities

The following nearby monitoring wells and storm drains (Figure 2) will be monitored for sodium permanganate oxidant before during and after injection to evaluate for potential migration of the sodium permanganate oxidant per 310 CMR 40.0045:

- Eight monitoring wells, MW-58S, MW-84S, MW-87S, MW-92S, MW-93A, MW-93B, and MW-94S (and MW-86S, if accessible); and
- Three storm drains, D-223, D-222, and one unlabeled drain.

The monitoring wells are located hydraulically downgradient, upgradient, and sidegradient of the Former Gas Holder Area source (Figure 2). Monitoring wells MW-87S, MW-92S, and MW-86S are located approximately 50 feet from the injection points, and MW-58S, MW-84S, MW-93S, and MW-94S are located approximately 200 feet from the injection points. The three storm drains are located hydraulically downgradient of the Former Gas Holder Area source.

The eight monitoring wells and three storm drains will also be monitored in the field before during and after injection by measuring temperature, conductivity; and pH (using a water quality meter) and testing for the presence of sodium permanganate oxidant (using a colorimeter). Water levels will be collected from the monitoring wells at MW-83S and SB-105 and upgradient at MW-92S and MW-84S to evaluate for mounding.

Task 4 – Post Injection Monitoring

After injection, the eight monitoring wells and three storm drains will be monitored for sodium permanganate oxidant. Water levels will also be monitored at MW-83S, SB-105, MW-92S, and MW-84S during each monitoring event. The post-injection monitoring will be conducted weekly for 5 weeks.

Task 5 - Confirmatory Sampling and Analysis

Confirmatory soil samples will be collected and analyzed to demonstrate the effectiveness of the injected sodium permanganate oxidant and to determine the average concentration of VC, DCA, DCE, and TCE in soil. Approximately four weeks after completing the oxidant injection, 10 proportionally distributed confirmatory soil samples will be collected from within the injection area. These soil samples will be preserved using EPA Method 5035 in the field and submitted to Severn-Trent Laboratories (STL) in Savannah, Georgia, for laboratory analysis of select VOCs (specifically VC, DCA, DCE, and TCE) using EPA Method 8260B.

Task 6 - Supplemental Soil Investigation

The purpose of the supplemental soil investigation is to confirm that there are no additional VC sources to ground water and to further support enhanced cometabolic degradation in the upper elevation concentration areas in the VC plume. Based on the VC isoconcentration contour of vinyl chloride (Figure 3) in ground water, there appear to be two locations where VC concentrations are elevated in the ground water, one at the known source area, and the other hydraulically downgradient of the known source area (Figures 3 and 4). Although there are several explanations for the observed dissolved VC distribution in ground water from the single known source area, additional soil borings will be advanced and completed. Two likely explanations for the observed VC distribution include:

- The distribution of the VC could be attributed to the changes in hydraulic conductivities between the fine sand unit, the medium to coarse sand unit, and changes in thickness of the saturated zone above the glacial till. The vinyl chloride plume concentrations are coincidental with the medium to coarse sand unit. The vinyl chloride concentration gradient within the plume is also coincidental with the medium to coarse sand unit thickness, as shown in the Figure 3-3 of the Phase II CSA Report.
- The ethylbenzene detected in ground water near the source area could provide a carbon source for enhancing the degradation of VC in ground water via cometabolic processes in the source area. Ethylbenzene has been detected in MW-87S (which is not in the source area) since 1998 at 19 milligrams per liter (mg/L) to 26 mg/L, while at the VC source (MW-83S), ethylbenzene concentrations have been decreasing in concentrations from 17 mg/L in early 1997 to 0.4 mg/L in late 1999. The source of ethylbenzene is from historical releases (1940s to 1995) 120 feet upgradient of the VC source area on the adjacent property. The ethylbenzene could be enhancing the degradation of VC in the source area. The ethylbenzene plume in ground water has not yet migrated to the area in the vicinity of MW-93S; therefore, enhanced cometabolic processes are not occurring at MW-93A.

Another source to ground water could be causing the two elevated concentration areas in the plume. However, this is not likely because the VC is only detected in the deep monitoring well screened 18 to 28 feet below ground surface (bgs) not the adjacent shallow monitoring well cluster MW-93B screened 5 to 15 feet bgs. To confirm this, a supplemental soil investigation is proposed in the downgradient elevated concentration area of the VC plume in the vicinity of monitoring well cluster MW-93A/MW-93B to confirm no other sources (Figure 3).

Two soil borings hydraulically upgradient of MW-93A will be continuously sampled using direct push or hollow-stem auger drilling techniques near the monitoring well where elevated VC concentrations in ground water were detected (MW-93A) 140 feet from the known source area. Samples will be continuously collected at two-foot intervals and visually examined for source material (i.e., fine-grained white material [off-grade PVC]). If less than one-foot recoveries are achieved, then the soil boring may be redrilled. Soil borings will be drilled to approximately 12 feet (two feet below the original grade).

Task 7 - Report

The RAM Report will include the following and will be incorporated into the RAM 120-day report or RAM completion report:

- Detailed summary of the activities implemented in connection with the Soil Remediation Plan and Ground-Water NA Monitoring Plan;
- Description of volume and concentration of chemical oxidant applied;
- Detailed description of injection system and methodology;
- Chronology and results of post-injection monitoring;
- Copies of field notes and the MADEP Remedial Monitoring Transmittal Form;
- Graphical and tabular presentation of confirmatory soil sampling results; and
- Conclusions regarding the effectiveness of the remedial effort.

The following information will be recorded during field and laboratory soil and ground-water monitoring per 310 CMR 40.0047, and included in the RAM report:

- Date and Time of Measurement Sample;
- Name of Sampler;
- Specifications of Sampling Method and Preservation;
- Date Laboratory Received the Samples;
- Sample Matrix;
- Analytical Method;
- Result of Analysis;
- Laboratory Detection Limit for Each Constituent for Each Sample;
- Documentation of Potential Quality Assurance Issues;
- Graphical and Tabular Presentation of Any Monitoring Results; and
- Description of the Pilot Study Design and Operation Activities.

Ground-Water Natural Attenuation Monitoring Plan

Objective

The objective of the Natural Attenuation Monitoring Plan will be to demonstrate that VC degradation is occurring at a rate sufficient to meet ground water criteria within a reasonable time frame.

Scope of Work

The scope of work for the Ground-Water Natural Attenuation Monitoring Plan will consist of the following tasks:

- Task 1 - Ground Water Sampling and Analysis;
- Task 2 - Water Level Measurements and Water Table Elevation Contour;
- Task 3 - Hydraulic Conductivity Testing and Analysis;
- Task 4 - Evaluation of Geochemical Analytical Results for NA;
- Task 5 - Comparison of Calculated Solute-Transport versus Monitored Plume Extent; and
- Task 6 - Report.

Task 1 - Ground-Water Sampling and Analysis

The ground-water sampling and analysis will be conducted to confirm the NA results obtained in December 1998 and November 1999.

Based on the initial NA screening in December 1998, there is geochemical evidence that biodegradation of VC, TCE, and DCA is occurring in ground water (i.e., ethene, ethane, and methane plumes coincidental with VC plume) via reductive dechlorination. In the MCP Phase II Report, a presentation of the initial screening results for NA was included for the Former Gas Holder Area (RTN 1-11901) (Pages 6-11 through 6-13; Figures 6-4, 6-5, and 6-6 of the Phase II CSA Report). The second November 1999 NA monitoring event was conducted to confirm the evidence observed during the initial event and to provide additional data that support a stable plume (i.e., rate of degradation is greater than migration). The November 1999 NA monitoring event was also conducted to evaluate whether NA can achieve the ground-water criteria after the source is remediated.

Ground water will be collected from the same nine monitoring wells included in the November 1999 NA monitoring event, except that MW-99S will be replaced with MW-98D. Monitoring well MW- 99S will not be sampled during this round because this well did not contain VC above detection limits of 0.001 mg/L. Ground water from MW-98D, the deeper well clustered with MW-99S contained low concentrations of VC at 0.004 mg/L and will be sampled and analyzed instead of MW-99S. Nine monitoring wells

included in this sampling event will be MW-58S, MW-83S, MW-87S, MW-93A, MW-94S, MW-95S, MW-96SF, MW-97S, MW-98D.

The ground water will be sampled for the same parameters analyzed in the November 1999 Natural Attenuation Ground-Water Sampling event. These include: VOCs, methane, ethane, ethene, nitrate, nitrite, ammonia, total organic carbon (TOC), chloride, iron (total and dissolved), manganese (total and dissolved), sulfate, sulfide, alkalinity, carbon dioxide, dissolved nitrogen, and dissolved oxygen. Ground-water samples will be submitted to Severn-Trent Laboratories in Savannah, Georgia, for analysis using the following methods:

Parameter	Method	Purpose
VOCs	USEPA Method 8260b	- Graphically evaluate degradation of VC along flow path or at single well over time. - Evaluate the extent of VC and ethylbenzene in ground water.
Methane	USEPA approved RSK 175	- Indicator of anaerobic conditions and of methanogenic bacteria. - Produced by the microbial reduction of carbon dioxide.
Ethane/Ethene	USEPA approved RSK 175	Metabolic end product of reductive dehalogenation of halogenated ethanes and ethenes.
Nitrate	353.2	Used as an electron acceptor after oxygen is depleted.
Nitrite	353.2	Product of nitrate reduction that is produced only under anaerobic conditions.
Total Organic Carbon	USEPA Method 9060	- Demonstrate potential availability of general growth substrates. - Evaluate whether reductive dechlorination is possible in the absence of anthropogenic carbon.
Ammonia	USEPA Method 350.2	- Ammonia is a nutrient and could serve as an aerobic co-metabolite. - Evaluate nitrate reduction.
Chloride	USEPA Method 300.0	Provide evidence of dechlorination. Note: potential road salt use could interfere with results.
Dissolved/Total Iron	USEPA Method 6010	- Iron is a nutrient; ferric iron (Fe+3) could be an electron acceptor. - Evaluate the activity of iron-reducing bacteria (ferrous iron [Fe+2]).
Dissolved/Total Manganese	USEPA Method 6010	- Manganese is a nutrient. - Indicate the presence of iron and manganese-reducing conditions.

Parameter	Method	Purpose
Sulfate	310.1	- Sulfate can be used as an electron acceptor. - Provide evidence of sulfate-reducing bacteria.
Sulfide	USEPA Method 376.1	Provide evidence of sulfate-reducing bacteria.
Alkalinity	USEPA Method 310.1	- Provide indication of the buffering capacity of the water and the amount of carbon dioxide dissolved in the water. - Increases due to biodegradation of organic compounds.
Carbon Dioxide	AM-15.1	Carbon dioxide can be used as an electron acceptor.
Nitrogen	AM-15.1	An essential nutrient of microbial growth and biodegradation.
Oxygen	- AM-15.1 - Chemets Kit - K-7501 - K-7512 - Flow through cell probe	- Highest energy-yielding electron acceptor for biodegradation of organic constituents. - Concentrations of dissolved oxygen will be used to delineate aerobic and anaerobic zones.

The samples will be collected using USEPA Region 1 Low Stress Purging and Sampling Procedures for the Collection of Ground Water Samples from Monitoring Wells, Revision 2, dated July 30, 1996, consistent with the procedures used in the November 1999 NA sampling event. These procedures are presented in Attachment 7. Packaging, shipping, and handling procedures are presented in the Quality Assurance Project Plan (QAPP) dated May 1994 for the Indian Orchard Plant.

Task 2 - Water Level Measurement and Water Table Elevation Contour

Water levels will be collected from the following 21 monitoring wells during a single day for preparation of a comprehensive water table elevation contour map: MW-58S, MW-59S, MW-60S, MW-61S, MW-64S, MW-83S, MW-84S, MW-85S, MW-86S, MW-87S, MW-92S, MW-93A, MW-93B, MW-94S, MW-95S, MW-96SF, MW-97S, MW-98D, MW-99S, SB-105 and TB-1. Access from NOVA Chemicals Inc., will be required at four upgradient monitoring wells (MW-61S, TB-1, MW-85S, MW-86S). The water table elevation contour data will be used to confirm ground-water flow directions, vertical gradients and horizontal gradients hydraulically upgradient and downgradient of the source area. Water levels are needed from additional monitoring wells to expand the contour map over a larger area. Water levels will be collected consistent with the existing QAPP for the Indian Orchard Plant.

Water levels from SB-105, MW-98D, and MW-93A will be used to evaluate vertical gradients in the saturated zone above the glacial till.

Task 3 - Hydraulic Conductivity Testing

During the ground-water sampling, the following additional field parameters will be monitored for use in a specific capacity test analysis: water levels before and immediately after pumping, as well as the flow rates and the duration of each flow rate if the flow rate varies.

Hydraulic conductivity values will be calculated using the specific capacity test analysis. The data from the specific capacity test will be reduced to a transmissivity estimate using a spreadsheet program (QSTRANS) developed by BBL based on an equation presented by W.C. Walton Selected Analytical Methods for Well

and Aquifer Evaluation, Illinois State Water Survey Bulletin 19, 1962. The Specific Capacity Test procedures are presented in Attachment 8.

Task 4 - Evaluation of Geochemical Analytical Results for NA

Concentration contours will be prepared for each parameter exhibiting a mappable concentration gradient. The degradation mechanism that appears to be active at the site will be identified and described for each of the parameters.

Task 5 - Comparison of Calculated Solute-Transport versus Monitored Plume Extent

This solute-transport calculation will be used to account for biodegradation and other natural attenuation factors. Solute-transport is simply a means to predict plume travel time and velocity. Most of the parameters (soil physical characteristics) needed to complete a solute-transport calculation have already been collected and reported in the Phase II CSA Report and in Attachment 2, except for hydraulic conductivity measurements in the fine-grained sand unit. The soil physical characteristics that affect advection (migration of dissolved chemicals due to the movement of ground water) and retardation (reduction in average chemical velocity due to the partial sorption of chemicals onto immobile soil particles and organic matter), were quantified during the Phase II CSA Report. The solute transport evaluation will focus on the estimated travel times for ethylbenzene and VC, the two most prevalent compounds detected above regulatory criteria at the Former Gas Holder Area. Solute-transport processes used in these calculations will include advection and retardation. Other factors such as dispersion and decay, however, can also affect plume migration but will not be assessed. Longitudinal dispersion can result in a somewhat more rapid advance of the leading edge of the dissolved chemical plume, although at very low concentrations. Transverse dispersion tends to widen or thicken the plume, but reduces the chemical concentration along the central axis of the plume. Decay due to biodegradation, hydrolysis, or other factors could also reduce the chemical concentrations within the plume. However, for the purpose of this relatively simple assessment, advection and retardation are typically assumed to be the most significant factors affecting plume velocity and travel time.

Advection

The advection rate will be estimated using representative values for hydraulic conductivity obtained in the Ground-Water Natural Attenuation Monitoring Plan – Task 3, and will also be based on the specific capacity test conducted on the medium to course sand as reported in the Phase II CSA Report.

The average linear ground-water velocity (advection rate) was estimated (after Freeze & Cherry, 1979) and reported in the Phase II CSA Report on page 3-9.

$$v = Ki/n,$$

where: v = ground-water velocity;
 K = hydraulic conductivity;
 i = hydraulic gradient; and
 n = effective porosity.

Based on the interpretation that the hydraulic conductivity (K) differs markedly between the medium/course sand unit and the surrounding fine-grained sand unit, solute-transport calculations will be solved separately for these two units.

The porosity values for the Former Gas Holder Area were determined based on laboratory results from samples obtained during the MCP Phase II CSA.

Retardation

The chemical constituent velocities (v_c) in the saturated zone above the glacial till will be estimated as $v_c = v/R$, where v is the average linear ground-water (advective) velocity; and R is the chemical-specific retardation factor.

Retardation factors for the on-site and off-site overburden (R_{ovb}) will be calculated as follows (Fetter, 1993):

$$R_{ovb} = 1 + (K_{oc})(f_{oc})\kappa_b / n,$$

where: K_{oc} = organic carbon-based partition coefficient;
 f_{oc} = fraction of organic carbon in soil;
 κ_b = dry soil bulk density; and
 n = soil porosity.

The soil parameters including f_{oc} were quantified based on laboratory analysis of soil samples obtained during for the MCP Phase II CSA in Table 4-14.

The travel time for VOCs within both the medium course sand unit and the fine-grained sand unit will be estimated using:

$$t = x/v_c,$$

where: t = ground-water travel time;
 x = distance; and
 v_c = chemical constituent velocity.

Based on a comparison of the monitored plume extent verses the calculated plume extent, a biodegradation rate will be calculated based on the procedures presented in the USEPA Technical Protocol for Evaluation Natural Attenuation of Chlorinated Solvents in Ground Water, September 1998.

Task 6 - NA Study Report

The NA study results of Tasks 1 through 5 will be included in the RAM 120- day initial status report or RAM completion report. The NA Study Report will include:

- X Description of the sampling activities;
- X Interpretation of the results and conclusions;
- X Concentration summary tables;
- X Historical concentration summary tables to demonstrate trends for select wells;
- X Water level summary tables to confirm ground-water flow direction;
- X Isoconcentration contours for VC, ethylbenzene, and select NA parameters;
- X Solute-transport calculations;
- X Hydraulic conductivity calculations;
- X Comparison of monitored verses calculated solute-transport to support NA;
- X Calculations of biodegradation rates; and
- X Updated medium to course sand isopach map.

Schedule

The drilling and ground-water monitoring portions of the RAM will be implemented no sooner than three days after RAM Plan submission and notification to the Department of Public Health and the Chief of Municipality in Springfield, Massachusetts. The sodium permanganate oxidant injection portion of the RAM will be implemented no sooner than seven days after RAM Plan submission and notification to the Department of Public Health and the Chief of Municipality.

RAM will be implemented no sooner than seven days after RAM Plan submission and notification to the Department of Public Health and the Chief of Municipality.

Owner/Operator Information

The current owner/operator of the Former Gas Holder Area is:

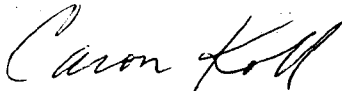
Solutia Inc.
730 Worcester Street
Springfield, Massachusetts 01151

The Solutia project manager for the Indian Orchard Plant RAM Plan is Roy P. Hart. Mr. Hart can be reached at (413) 740-2682 as indicated on the MADEP RAM transmittal form. The MADEP RAM Plan transmittal form is provided in Attachment 10.

If you have any questions or comments regarding this MCP compliance schedule, please contact either Mr. Roy P. Hart of Solutia at (413) 730-2682, or me at (315) 446-2570 x148.

Sincerely,

BLASLAND, BOUCK & LEE, INC.



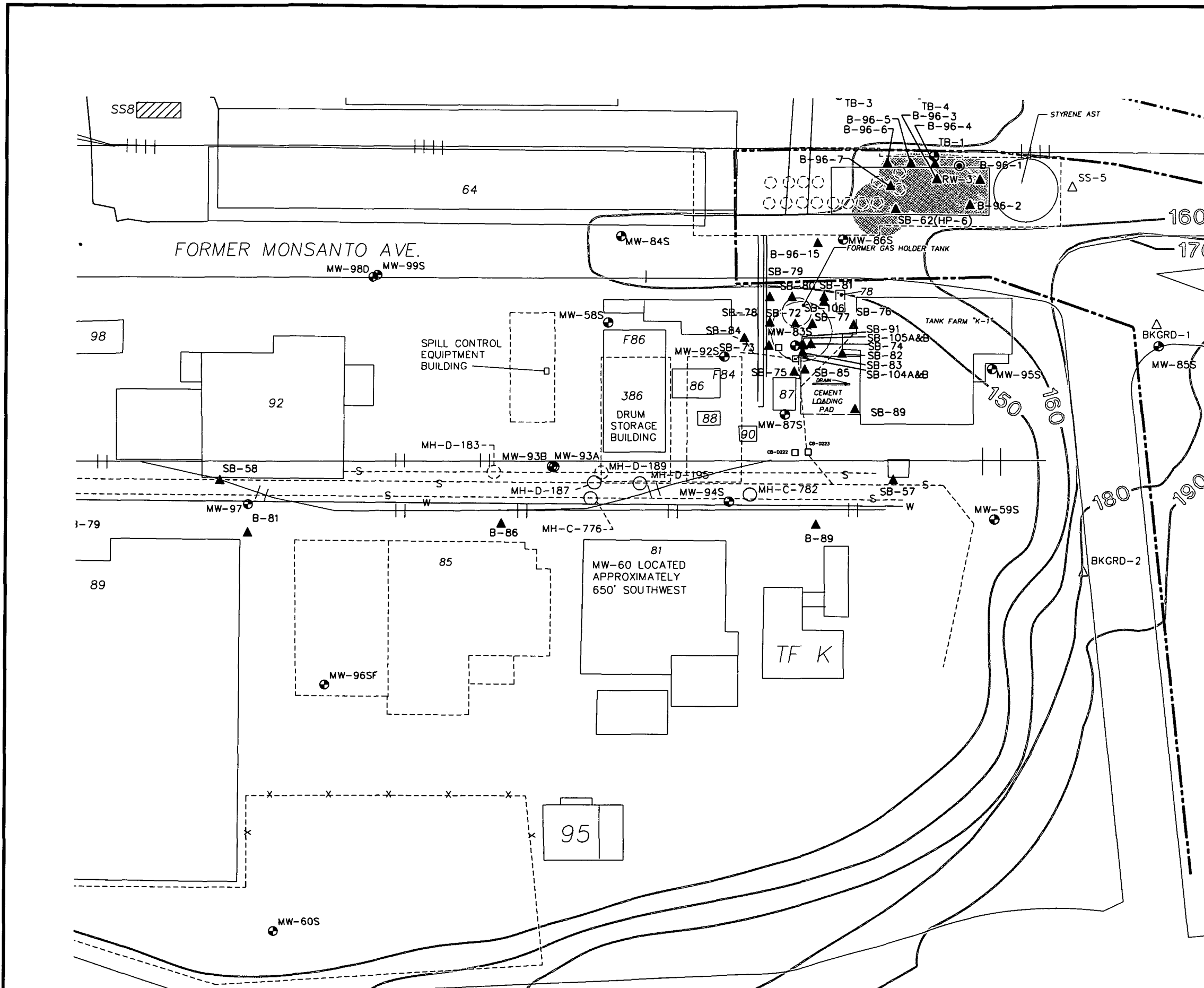
Caron S. Koll, L.S.P.
Senior Project Geologist II

KAG/CSK/plf
Enclosures

cc: Mr. Edward Weagle, MADEP
Mr. Raphael Cody, USEPA
Mr. Roy P. Hart, Solutia Inc.
Mr. Michael L. House, Solutia Inc.
Mr. Andrew N. Johnson, P.E., Blasland, Bouck & Lee, Inc.

Figures: 1 - Sample Location Map
 2 - Monitoring Point Locations
 3 - Vinyl Chloride Isoconcentration Contour Map - November 1999
 4 - Water Table Elevation Contour Map - November 1999

Attachments: 1 - Draft Treatability Study Report dated February 25, 1999
 2 - Chem-Ox Pilot Test Summary Report dated October 1, 1999
 3 - Typical Composition of Sodium Permanganate MSDS and Fact Sheets
 4 - MADEP Remedial Monitoring Transmittal Form
 5 - Utility Locating Standard Operating Procedures
 6 - Schematic of the PCOIS
 7 - USEPA Region I Low Stress (Low Flow) Purging and Sampling Procedures for
 the Collection of Ground-Water Samples from Monitoring Wells, July 30, 1996.
 Revision 2.
 8 - Specific Capacity Test Procedures
 9 - RAM Plan Schedule
 10 - MADEP RAM Transmittal Forms

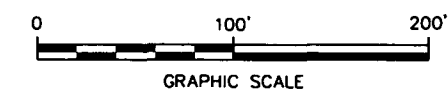


LEGEND

- MONITORING WELL
- ▲ SOIL BORING OR DRIVEN WELL
- ◎ RECOVERY WELL
- △ SURFACE SOIL SAMPLE
- 140— TOPOGRAPHIC ELEVATION CONTOUR (FT, ASPD)
- W — UNDERGROUND WATER LINE
- S — UNDERGROUND SEWER
- D — UNDERGROUND STORM DRAIN
- JET — FORMER UNDERGROUND JET FUEL LINE
- FORMER BUILDING
- VINYL CHLORIDE SOURCE AREA (RTN-1-11901)
- ETHYLBENZENE SOURCE AREA (RTN 1-11694)

NOTES:

1. BASE MAP PREPARED FROM "BUILDING DESIGNATION PLAN" SUPPLIED BY Solutia Inc., 1993, AT A SCALE OF 1" = 200'.
2. THE LOCATION OF BORINGS AND WELLS, ARE SURVEYED BY BBL, BASED ON GRID COORDINATES SUPPLIED BY Solutia Inc., EXCEPT FOR FOUNDATION BORINGS (SEE NOTE 5).
3. BUILDINGS, ROADS, AND HYDROGRAPHY SHOULD BE CONSIDERED APPROXIMATE ONLY. FEATURE LOCATIONS ADJUSTED PER Solutia Inc. CONSENT ON 11/16/94. FORMER BUILDINGS BASED ON SANBORN MAPS AND Solutia Inc. PLANT MAPS PROVIDED 8/8/96. APPROXIMATE UNDERGROUND UTILITY LOCATIONS ADDED 8/98 BASED ON PLANT UTILITY DRAWINGS.
4. ELEVATIONS OF WELLS AND SOIL BORINGS ARE BASED ON Solutia/NOVA CHEMICALS PLANT DATUM (SPD) WHICH IS 0.45' HIGHER THAN USGS NATIONAL GEODETIC VERTICAL DATUM OF 1929.
5. ADDITIONAL BORING LOCATIONS WERE DRILLED FOR GENERAL PLANT (B-72) FROM 1970 THROUGH 1982. SB-57 THROUGH SB-61 WERE DRILLED IN DECEMBER 1994 TO EVALUATE SOILS AND GROUND WATER ASSOCIATED WITH A SEWER. NONE OF THESE BORINGS WERE SURVEYED TO THE PLANT GRID SYSTEM, HOWEVER THEY WERE TIED TO EXISTING UTILITY MANHOLES.
6. SOIL BORING LOCATIONS B-96-08 THROUGH B-96-19 WERE INSTALLED IN OCTOBER 1996 AND ARE APPROXIMATE.
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8. SURVEY OF TEMPORARY WELLS DW-1 THROUGH DW-7 WAS PERFORMED BY HILL ENGINEERS. SURVEY OF MONITORING WELLS TB-1 THROUGH TB-7, MW-61S THROUGH MW-95S, AND SB-71 THROUGH SB-106 WERE SURVEYED BY BBL.
9. SURFACE SOIL SAMPLE LOCATIONS ARE APPROXIMATE.
10. SOIL BORINGS (B-96-1 THROUGH B-96-7) ARE APPROXIMATE AND LOCATED BASED ON SITE FEATURES, (EXISTING STYRENE TANK), NOT WELLS (T&B, 1998).



SOLUTIA INC.
EASTERN INDIAN ORCHARD PLANT
SPRINGFIELD, MASSACHUSETTS
FORMER GAS HOLDER AREA (1-11901) RAM PLAN

SAMPLE LOCATION MAP

BBL BLASLAND, BOUCK & LEE, INC.
engineers & scientists

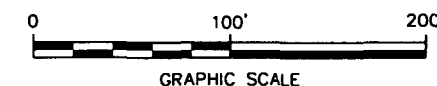
FIGURE
1

LEGEND

- MONITORING WELL
- ▲ SOIL BORING OR DRIVEN WELL
- ⊙ RECOVERY WELL
- △ SURFACE SOIL SAMPLE
- TOPOGRAPHIC ELEVATION CONTOUR (FT, ASPD)
- W — UNDERGROUND WATER LINE
- S — UNDERGROUND SEWER
- D — UNDERGROUND STORM DRAIN
- JET — FORMER UNDERGROUND JET FUEL LINE
- FORMER BUILDING
- VINYL CHLORIDE SOURCE AREA
- ETHYLBENZENE SOURCE AREA
- ND(0.2) NOT DETECTED (DETECTION LIMIT IN mg/L)

NOTES:

1. BASE MAP PREPARED FROM "BUILDING DESIGNATION PLAN" SUPPLIED BY SOLUTIA INC., 1993, AT A SCALE OF 1" = 200'.
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4. ELEVATIONS OF WELLS AND SOIL BORINGS ARE BASED ON SOLUTIA/NOVA CHEMICALS PLANT DATUM (SPD) WHICH IS 0.45' HIGHER THAN USGS NATIONAL GEODETIC VERTICAL DATUM OF 1929.
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9. SURFACE SOIL SAMPLE LOCATIONS ARE APPROXIMATE.
10. SOIL BORINGS (B-96-1 THROUGH B-96-7) ARE APPROXIMATE AND LOCATED BASED ON SITE FEATURES, (EXISTING STYRENE TANK), NOT WELLS (T&B, 1996).
11. RESULTS ARE BASED ON UNVALIDATED DATA (UNITS mg/L).



SOLUTIA INC.
EASTERN INDIAN ORCHARD PLANT
SPRINGFIELD, MASSACHUSETTS
FORMER GAS HOLDER AREA (1-11901) RAM PLAN

VINYL CHLORIDE ISOCONCENTRATION CONTOUR MAP - NOVEMBER, 1999

BBL BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE
3

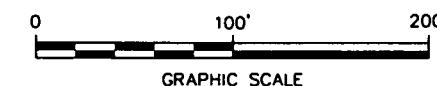
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LEGEND

- MONITORING WELL
- ▲ SOIL BORING OR DRIVEN WELL
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- FORMER BUILDING
- VINYL CHLORIDE SOURCE AREA
- ETHYLBENZENE SOURCE AREA
- ← DIRECTION OF GROUNDWATER FLOW

NOTES:

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11. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL.

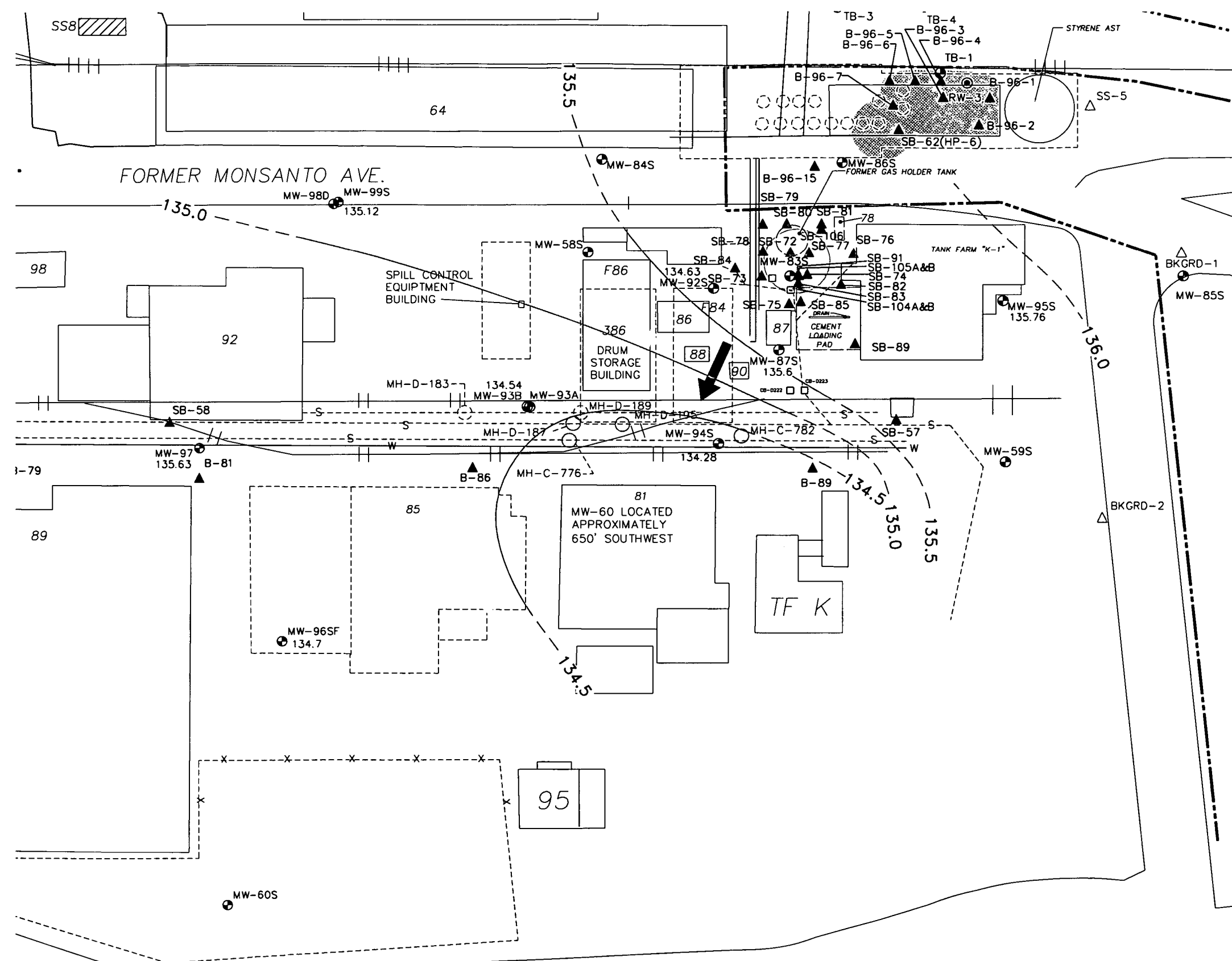


Solutia Inc.
EASTERN INDIAN ORCHARD PLANT
SPRINGFIELD, MASSACHUSETTS
FORMER GAS HOLDER AREA (1-11901) RAM PLAN

WATER TABLE ELEVATION CONTOUR MAP - NOVEMBER, 1999

BBL BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE
4



Attachments

BLASLAND, BOUCK, & LEE, INC.
e n g i n e e r s & s c i e n t i s t s

Attachment 1

Draft Treatability Study Report Dated February 25, 1999



**XPERT
DESIGN
AND
DIAGNOSTICS, LLC**

199 CONSTITUTION AVENUE, BLDG. 1, FLR. 2 PORTSMOUTH, NH 03801 (603) 433-0191 (603) 431-7807 FAX

February 25, 1999

Ms. Caron S. Koll, L.S.P.
Senior Project Geologist
Blasland, Bouck, & Lee, Inc.
6723 Towpath Road
P.O. Box 66
Syracuse, NY 13214-0066

Re: Draft Treatability Study Report—Former Gas Holder Area, Solutia, Inc., Indian Orchard Plant, Springfield, Massachusetts

Dear Caron,

XDD, LLC (XDD) appreciates the opportunity to be of assistance to Blasland, Bouck & Lee (BB&L) on the development of a cost-effective remedial approach on the above referenced site. Attached please find for your review a copy of the "Draft Treatability Study for the Application of an In-Situ Oxidation of Vinyl Chloride, Former Gas Holder Area, Solutia, Inc., Indian Orchard Plant, Springfield Massachusetts". XDD has reviewed this report with the Environmental Research Institute at the University of Connecticut (ERI).

Project Summary

A two phase study was performed on samples of the white material collected from approximately 6 feet below grade and identified as the potential source of Vinyl Chloride in ground water in the Former Gas Holder Area of the Site. Phase I of the study involved characterization of the white material. Phase II involved column studies to evaluate the efficacy of in-situ chemical oxidation for treatment of the white material, to reduce the levels of Vinyl Chloride to below the MCP UCL of 20 mg/kg.

Phase I Results

A series of physical/chemical tests were performed by the ERI on the white material to understand its origin and relationship to the Vinyl Chloride identified in ground water at the Site. The results of the testing strongly indicate that the white material is standard grade PVC. This identification is consistent with past PVC manufacturing operations at the plant. A review of historic Site aerial photography by BB&L identified that the Former Gas Holder Area was filled to its current elevation some time between 1946 and 1952. It is likely that the white material "PVC" represents a poor quality batch manufactured during the 1946-1952 time frame (again,

consistent with past plant operations) that was deposited in the Former Gas Holder Area and filled over when re-contouring of that part of the Site occurred.

The white material was further analyzed for VOC content, relatively high (hundreds of mg/kg) levels of Vinyl Chloride and lesser levels of di- and tri-chloroethene were measured. An evaluation of the manufacturing processes and degradation properties of PVC (through a literature review and PVC manufacturer discussions and/or technical data) was carried out. As a result of these analyses it is highly likely that the chlorinated hydrocarbons detected represent residuals on the PVC resulting from the PVC manufacturing processes and not as a result of degradation of the white material. Therefore, removal of these residuals from the white material should eliminate the source of Vinyl Chloride to the ground water in the Former Gas Holder Area.

As a reality check on this evaluation, XDD performed a calculation on the potential flushing of the Vinyl Chloride from the white material that could have occurred since deposition of the material on site. The assumptions used in the calculations were:

- Material deposited in 1946 (i.e. in ground 52 years)
- Ground water velocity (from the site data)
 - Hydraulic gradient = 0.006
 - Hydraulic conductivity = 3.3×10^{-3} cm/sec
- Vinyl Chloride concentration in contact with ground water flowing through white material = 20 mg/l (from column study results)
- Thickness of white material = 3 to 6 inches
- Length of white material deposit parallel to ground water flow = 30 feet (estimated from BB&L report figures on area of soil impact and ground water flow direction).

The analysis indicates that approximately 40 gallons of water passes through a one-foot wide strip of the white material per year or approximately 2080 gallons of water in 52 years. At a concentration of 20 mg/l in water this equates to 150,000 mg of Vinyl Chloride that was flushed out of a foot-wide strip of the white material since 1946. This mass was removed from approximately 375,000 kg of white material or approximately 0.4 mg Vinyl Chloride were flushed per kg of white material. This calculation suggests two main conclusions:

- It is feasible that the white material was deposited in the 1946-1952 time frame and may have been losing Vinyl Chloride through flushing since then, and
- Under the current conditions (as Vinyl Chloride has been measured on the white material at concentrations in excess of 200 mg/kg) the white material could remain a significant source of Vinyl Chloride for a very long time period.

Phase II Results

These column studies were performed on the site soils to evaluate the efficacy of in-situ oxidation of the white material as a remedial measure for the Former Gas Holder Area of the Site. Chemical oxidants (sodium permanganate, in this case) have been shown to be highly effective at destructing unsaturated chlorinated hydrocarbons (as present at the Site). However, sufficient quantities of oxidant and sufficient contact time between the oxidant and the target chemicals for destruction are needed to overcome the native soils demand for the oxidant (SOD) and to ensure destruction of the target chemical, respectively.

The results from the column studies indicated that:

- The native soil shows a relatively high background SOD likely as a result of the relatively high (2.6%) organic content of the uncontaminated soil sample tested.
- Flushing of the control column with site ground water only indicates (as per the previous calculation) that after approximately 230 pore volumes (equivalent to 103 years under field conditions) significant concentrations of Vinyl Chloride (~5 mg/l) are still emanating from the column white material.
- Flushing of the test column initially with chemical oxidant followed by the site ground water indicates the following:
 - There is an initial rapid reaction between the chemical oxidant and the residual target chlorinated hydrocarbons on the white material and adjacent soils.
 - The resulting Vinyl Chloride concentrations emanating from the column during and following oxidant flushing was less than the detection limit of 1 µg/l. This indicates that the oxidant was highly effective in destructing the available residual Vinyl Chloride on the white material.
 - The low levels of VOCs detected in the soils following the oxidant flushing experiment coupled with the non-detectable levels of VOCs in the column effluent suggest that a portion of the VOCs are contained within the porous structure of the white material. Further, the data suggests that the release of these contained VOCs will be slow and at low levels due to mass transfer limitations. In addition, it is suggested that a longer contact time with the oxidant would be needed to completely destruct the VOCs within the white material porous structure.
 - The residual concentrations of Vinyl Chloride on the white material following treatment by the chemical oxidant are less than the MCP UCL of 20 mg/kg.

Summary and Recommendation

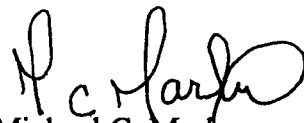
The white material has been identified as PVC that, as a result of manufacturing processes, contains residual quantities of Vinyl Chloride and di-and tri-chloroethene. The target VOCs are rapidly destroyed when contacted by sufficient concentrations of the chemical oxidant sodium permanganate. Low levels of VOCs within the white material would likely require longer contact time with the chemical oxidant to be completely destroyed.

The original concept of utilizing a batch chemical oxidant treatment to remediate the white material and adjacent impacted soils on site is valid. The key to the success of the process will be the method of application of the chemical oxidant to ensure contact between the oxidant and the impacted materials/soils. Currently a Geoprobe/slurry type application is envisioned. The soils description from the grain size analyses suggests a less permeable layer below the white material which would facilitate contact between the injected oxidant and the impacted materials.

It is suggested that the application be performed in a two phase approach. Phase I would involve a field demonstration of the batch process within a small area of the impacted volume, which could be monitored appropriately to demonstrate the success of the approach. Phase II would involve, if Phase I is successful, batch application of the oxidant over the remainder of the impacted volume.

Again, XDD and ERI appreciate the opportunity to be of continued assistance to BB&L and Solutia, Inc. on this interesting and challenging project. If you have any questions on the report, this cover letter or the project in general, please do not hesitate to call me at 603-433-0191.

Sincerely,
XDD, LLC


Michael C. Marley
President

cc: Dr. Pradeep Chheda, ERI
Ed Droste, XDD

MCM/cg

Final Draft Report

on the

**TREATABILITY STUDY FOR THE APPLICATION OF
AN IN-SITU OXIDATION OF VINYL CHLORIDE,
FORMER GAS HOLDER AREA, SOLUTIA, INC.,
INDIAN ORCHARD PLANT, SPRINGFIELD,
MASSACHUSETTS**

Prepared by:

Pradeep Chheda, PhD, PE



**The Environmental Research Institute
The University of Connecticut
270 Middle Tpke
Storrs, Connecticut 06269**

Submitted to:

**Xpert Design and Diagnostics, LLC.
199 Constitution Ave
Building 1, Floor 2
Portsmouth, NH 03801**

February 24, 1999

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1.0 INTRODUCTION

Xpert Design and Diagnostics (XDD), retained the Environmental Research Institute (ERI) at the University of Connecticut to conduct a treatability study to test the potential application of an in situ chemical oxidation technology using permanganate to remediate a source material impacted with volatile organic chemicals (VOCs), predominantly vinyl chloride (VC), at Solutia, Inc. Indian Orchard Plant in Springfield, Massachusetts.

Based on the findings from earlier site characterization (by Blasland, Bouck and Lee (BBL), Inc.), VC is identified as a target parameter at the site (to meet the criteria of MCP UCLs of 20 mg/kg for VC). It was considered likely that the white material found at the site at a depth of about 5 to 6 feet below ground level (BGL) might be serving as a continued source of VC. Moreover, based on the site history, the white material was suspected to be a poly vinyl chloride (PVC). A treatability study, comprised of further characterizing the white material and evaluating the efficacy of an in situ oxidation of VOCs using sodium permanganate (NaMnO_4) as an oxidant, was carried out.

The primary goals of this study were to

- further characterize the white material with respect to it acting as a source of VC,
- evaluate the leaching behavior of VC from the white material,
- investigate the efficacy of insitu oxidation (leading to mineralization) of VC using sodium permanganate as an oxidant, and
- determine background soil oxidant demand for permanganate

In order to fulfil the above-mentioned goals, the study was conducted in two phases. Phase I comprised of characterization of the white material (obtained from the site) to better understand its function with respect to the VOCs by analyzing it for various parameters including glass transition temperature, molecular weight distribution and infrared absorption. In Phase II, column experiments were carried out to determine the efficiency of the chemical oxidation and the oxidant demand of the native soil using both the contaminated and uncontaminated soil samples obtained from the site. The experimental protocol and results obtained from this screening study are presented in this report.

2.0 EXPERIMENTAL PROTOCOL

2.1 Sampling – Soil samples, both within the impacted area and from an uncontaminated area of the site, were collected by BBL on separate occasions and shipped overnight to ERI. The soil cores were collected in 1.7 inch dia x 2 ft long stainless steel or Teflon liners.

Initially, soil core, SB-91, (in Teflon liner) containing the white material was obtained at a depth between 6 ft 6 inch-8 ft 5.25 inch from within the source zone. The core was preserved over ice packs in a cooler and shipped overnight to ERI for Phase I characterization of the white material.

Moreover, two pairs of soil cores (a pair consisting of one Teflon liner and one steel liner containing soil sample from adjacent locations), i.e., SB 104 (A and B for Teflon and steel, respectively) and SB105 (A and B) and were obtained at a depth between 6 ft to 8 ft BGL in the source zone. A soil sample was obtained from an uncontaminated area (SB106) in a steel liner at a depth between 6 ft to 8 ft BGL.

The purpose of collecting soil in Teflon liners was to visually locate appropriate depth of white material to ensure correct selection of steel cores for the column tests. In order to select most appropriate fraction of the core for the test, the soil samples collected using the stainless steel liner and Teflon liner at a given location were collected within one foot distance. After collecting soil samples, both ends of the cores were covered with Teflon tape and capped and shipped to ERI under refrigeration in a cooler for next-day delivery.

Uncontaminated groundwater, to be used in the column experiments, was also obtained from existing monitoring well (MW 95S) at the site in several 4-L Tedlar bags and shipped overnight to ERI.

The analyses of the various groundwater and soil samples are presented in Tables 1 and 2, respectively. The experimental methods for both phases of the study are described below.

2.2 Phase I: Characterization of White Material

A Teflon core obtained from the source zone containing white material was cut open vertically and a small sample of the white material was carefully and quickly transferred into two 5-mL glass vials. The sample of white material was submitted to the Institute of Material Science at the University of Connecticut for analysis of molecular weight distribution (by gel permeation chromatography), glass transition temperature (by differential scanning calorimetry) and infrared spectroscopy. The purpose of these tests was to compare these parameters of the white material with that of a standard PVC material. Moreover, a thermal desorption gas chromatography/mass spectroscopy (GC/MS) method was also used to identify and semiquantitatively assess the organic compounds associated with the white material.

The remaining soil from the Teflon core was qualitatively evaluated for color and texture and accordingly divided into five sections. Each soil section was air dried and analyzed for grain size distribution.

2.3 Phase II: Column Study

Two pairs of soil cores (a pair consisting of one Teflon liner and one stainless steel liner containing soil sample from adjacent locations), i.e., SB 104 (A and B for Teflon and steel, respectively) and SB105 (A and B) and were obtained at a depth between 6 ft to 8 ft from the source zone. Additionally, a soil sample was obtained from an uncontaminated area (SB106) in a steel liner at a depth between 6 ft to 8 ft.

In total, three column tests were conducted on the soil cores obtained from the site. The tests included: (1) flushing the uncontaminated soil core (UC-1) with NaMnO_4 solution to calculate the native soil oxidant demand, (2) flushing a soil core (C-1) containing the white

material with a solution of NaMnO_4 to demonstrate the efficacy of oxidation of target VOCs, and (3) flushing a soil core (C-2) containing the white material with uncontaminated groundwater as a control for comparison with C-1.

In a typical column test, a 1.69 inch diameter x 6 inch long section of stainless steel liner containing soil sample was cut at both ends by 1.5 inch to get a 3 inch long core for testing. Due to the variability in the location of the white material in each core the soil from the Teflon cores were used in the study. Thus, to ensure the presence of white material in a stainless steel soil column, a portion of Teflon core containing the maximum quantity of white material (visual determination) was cut to the desired dimension and the soil from the Teflon core was extruded into a 3 inch long stainless steel core, with minimum disturbance. A small portion of soil was removed from each end of the 3-inch long core and was stored for analysis of VOCs, pH and moisture content. The soil sample for VC analysis was stored in methanol until analyzed. After removal of the small portions of soil from both ends of the test column, the empty space was filled with 1 mm diameter glass beads. Finally, the glass beads were secured in place by inserting stainless steel mesh on both ends of the core, and the column was mounted on a stand. After completion of the test (except in the case of UC-1), the column was allowed to gravity drain for at least two hours and dismounted from the stand. The soil was then extruded from the test column and a small portion was collected in methanol for the determination of VC from both the top and bottom ends of the core. The extruded soil was also analyzed for moisture content and visually inspected for any texture change as a result of reaction.

In the case of test column UC-1, a solution of $\sim 4,160$ mg/L NaMnO_4 (in deionized water) was continuously fed to the column in an upward flow mode using a peristaltic pump at a nominal flow rate of 0.3 mL/min. The effluent was monitored for pH, chloride and residual NaMnO_4 . This column test was run for three days.

In the case of test column C-1, a solution of $\sim 4,200$ mg/L NaMnO_4 was fed to the column upward flow mode using a peristaltic pump at a nominal flow rate of 0.25 mL/min. The effluent was monitored for pH, VC, chloride and residual NaMnO_4 . The effluent samples collected for pH and residual NaMnO_4 were analyzed immediately, whereas, the effluent samples collected for VC and chloride analyses were quenched with sodium thiosulfate to stop the reaction between NaMnO_4 and VOCs, and stored in a refrigerator until analyzed. The permanganate flushing was continued until the concentration of NaMnO_4 in the effluent stabilized. At this point, the eluent was changed to uncontaminated site groundwater and the test was continued until NaMnO_4 concentration in the effluent dropped to essentially zero.

Test column C-2 was run as a control. In column C-2, uncontaminated groundwater was continuously fed to the column containing contaminated soil (and the white material) in an upward flow mode using a peristaltic pump at a nominal flow rate of 0.24 mL/min. The effluent was monitored for pH, chloride and VC. This column test was run for 18 days.

Various experimental parameters/conditions and raw data for the column studies are presented in Appendix I.

3.0 RESULTS AND DISCUSSION

3.1 Characterization of White Material

The results obtained from the various characterization methods are as follows.

Gel permeation chromatography (GPC)

The molecular weight distribution curves (based on polystyrene standards) for the white material obtained from the site and a typical industrial grade PVC are presented in Figures 1 and 2, respectively. The weight average molecular weight (Mw), number average molecular weight (Mn) and polydispersity indices for both the white material and standard PVC are as follows.

	<u>White Material</u>	<u>Standard PVC</u>
Weight average molecular weight (Mw)	141,000	168,000
Number average molecular weight (Mn)	85,600	101,000
Polydispersity index (Mw/Mn)	1.65	1.66

While the white material exhibited about 16% lower molecular weight than the PVC standard, it still is considered as normal PVC.

Thermogravimetric analysis (TGA)

The thermogram showing weight loss vs. temperature, of the white material is shown in Figure 3. A weight loss of about 40% is clearly observed in the temperature range 250-350 °C, most likely due to a characteristic loss of HCl as the first step in the thermal degradation of PVC.

Differential scanning calorimetry (DSC)

The glass transition temperatures (Tg) for both the standard PVC and white material were determined by DSC. The heat flow vs. temperature curves for both the standard PVC and the white material are presented in Figures 4 and 5, respectively. Both have glass transition temperatures (Tg) that are very close to each other and consistent with known Tg values for PVC. The slightly higher Tg for PVC standard (86.1 °C) vs. 84.4 °C for the white material is consistent with the higher molecular weight of the PVC standard. In summary, the characteristic TGA thermogram, and the DSC and GPC results for the white material are indicative of a fairly typical industrial grade PVC.

Infrared spectroscopy and thermal desorption GC/MS

The IR spectra for both standard PVC and the white material are shown in Figure 6. Once again, the similarity between the IR spectra of the white material and standard PVC supports the conclusion drawn above.

The chromatogram (Figure 7) of white material obtained by thermal desorption-gas chromatography-mass spectrometry (TD/GC/MS) indicates the presence of low levels of vinyl chloride, dichloroethene (DCE) and trichloroethene (TCE). These compounds are most likely from vinyl chloride monomer and the compounds (e.g., DCE and TCE) that were used in the manufacturing of PVC. Benzene, of uncertain origin, was also detected at low levels. Other organic compounds detected by GC/MS are undecane, naphthalene, dodecanoic acid and docosane.

Thus, from the above analyses, it appears that the white material found at the site is primarily polyvinyl chloride that is comparable to typical industrial PVC having low contents of vinyl chloride, dichloroethene and trichloroethene, as well as benzene. The chloro-compounds are most likely unpolymerized materials from the polymerization process used in the manufacturing of PVC. Appendix II presents excerpt from PVC manufacturing process description that supports these findings.

Based on the TD/GC/MS results, an additional sample of the white material was analyzed for quantification of target VOCs using methanol extraction followed by GC/MS. The results of GC/MS analysis indicated the presence of 2400 mg/kg (dry material) VC, 350 mg/kg (dry material) *cis*-a,2-dichloroethene and 270 mg/kg (dry material) TCE.

The appearance of soil core SB-91 is shown in Slides #1 and #2 (Appendix III). The soil from this core was also analyzed for grain size distribution. The two feet long core was cut vertically (Slide #2) and evaluated for the color and texture of soil. Based on the visual inspection, five distinct sections of soil were identified as follows.

<u>Depth (BGL)</u>	<u>Color/Texture</u>
6 ft 6 inch - 6 ft 11.5 inch	Dark brown, sandy, mixed silt with gravel
6 ft 11.5 inch – 7 ft 6.5 inch	Light brown, sand
7 ft 6.5 inch – 7 ft 9 inch	White material, unmixed with soil
7 ft 9 inch – 8 ft 0 inch	Gray, white material mixed with clay and small gravel
8 ft 0 inch – 8 ft 5.25 inch	Brown sandy soil with large gravel up to 1 inch dia

The grain size distributions of soil samples from the five sections of the core are presented in Figure 8. A band of the white material of approximately 2.5 inch thick is clearly visible (Slide #1) in the core. Moreover, more than 70% (on weight basis) of the material was found to be in narrow size range of 0.09 to 0.25 mm.

3.2 Column Study

The column experiments were carried out on both the contaminated and uncontaminated soil samples obtained from the site to: (1) determine the soil/oxidant demand and soil/oxidant interactions under continuous flow conditions, and (2) determine the efficacy of VOCs oxidation under actual site soil and groundwater conditions.

A total of three column tests were conducted on the soil cores obtained from the site. The tests included,

- ◆ flushing an uncontaminated soil core (UC-1) with NaMnO_4 solution for the determination of soil oxidant demand (SOD),
- ◆ flushing a contaminated soil core (C-1) containing the white material with a solution of NaMnO_4 to assess the efficacy of oxidation of VC, and
- ◆ flushing a contaminated soil core (C-2) containing the white material with uncontaminated groundwater as a test control.

3.2.1 Soil Oxidant Demand (UC-1 Test)

A soil column treatability test was conducted using NaMnO_4 fed continuously into a column containing uncontaminated soil (UC-1). The purpose of this test was to evaluate the oxidant demand of the site soil for NaMnO_4 . A partial characterization of soil used for estimating SOD is presented in Table 2. The pH of the soil was 7. Although this soil was obtained from an uncontaminated area, it showed trace levels of VC as evident from the low concentrations of VC in the soil analyzed from the top (0.07 mg/kg) and the bottom (0.001 mg/kg) portion of the column prior to flushing with oxidant. The behavior of uncontaminated soil toward the oxidant is depicted in Figure 9 (a), which shows the concentration of NaMnO_4 and pH in the column effluent vs. time. The change in Cl^- concentration with time is depicted in Figure 9 (b). Assuming a typical void ratio of 25%, the pore volume in the column would be 25.5 mL. When a solution of 4,160 mg/L NaMnO_4 was passed through this column at an average flow rate of 0.29 mL/min (superficial velocity of 0.94 ft/d and a throughput of ~16.4 pore volumes per day), it took 80 min for NaMnO_4 to first appear in the effluent. Moreover, it took ~3 days for the concentration of NaMnO_4 in the effluent to reach 88% of the influent concentration. The mass balance calculations for NaMnO_4 show that the uncontaminated soil exerts an oxidant demand of 11.7 g NaMnO_4 /kg soil (dry). This is relatively high SOD, indicating that the uncontaminated soil at the site is quite reactive toward NaMnO_4 . The pH of effluent remained relatively unchanged throughout the run at around 7. The chloride level in the column effluent decreased from 105 mg/L at 2.1 h to essentially zero in about 8 h. This indicates that the chloride associated with the porewater and residual water in the soil was flushed out during the permanganate flushing. The alkalinity of the soil used in this column was found to be 259 g CaCO_3 /kg (dry soil) indicating that the soil exhibits moderate capacity to resist a change in pH.

Upon visual inspection of the soil after it was removed from the core at the end of the experiment, the soil appeared to be silty (possibly rich in natural organic content). A part of the soil sample that was collected from this column prior to beginning this experiment was, therefore, analyzed for total organic content (TOC, by loss of ignition method) and showed a TOC of 2.6%. Thus, this high TOC content may partly explain the relatively high SOD determined for the native soil.

3.2.2 Efficacy of VC Oxidation (C-1 test)

The second column experiment (C-1) was conducted to assess the efficacy of the oxidation of VC under continuous NaMnO₄ flushing mode. A partial characterization of soil used for this test is presented in Table 2. The pH of the soil was 7. Although, the soil sample from the top end of the column did not indicate presence of any VOCs, the soil sample from the bottom end (essentially white material) showed ~118 mg/kg VC and ~77.5 mg/kg *cis*-1,2-DCE. The alkalinity of the soil was found to be 232 gCaCO₃/kg (dry soil) indicating that soil exhibits moderate capacity to resist the change in pH.

This test was run by first passing 4,200 mg/L NaMnO₄ solution through the column at a nominal flow rate of 0.25 mL/min (superficial velocity of 0.78 ft/d and a throughput of ~13.7 pore volumes per day) for 44.7 h, followed by groundwater flushing for an additional 29 h. The effluent was monitored for pH, chloride, residual permanganate and the target compound VC. The concentration profiles for residual NaMnO₄ and pH in the effluent are depicted in Figure 10 (a), whereas, the concentration of chloride in the effluent vs. time is shown in Figure 10 (b). It took about 36 min for eluent to come out at the effluent end and about the same time for the appearance of NaMnO₄. The VC concentration in the effluent during the entire duration (74 h) of flushing was below the detection limit (of 1 µg/L). Typically, because of the nature of the soil column test, there is an initial flush of the target compound in the column effluent, followed by products of oxidation (e.g., Cl⁻, CO₂, H⁺ or OH⁻). However, no detection of VC (detection limit = 1 µg/L) in the effluent suggests that it was rapidly oxidized by permanganate in the column. This is evident from the increase in chloride level in the effluent. For example, chloride level in the effluent increased from ~19 mg/L at 1.3 h to 41 mg/L at 3.1 h and then steadily decreased to 13 mg/L at 27 h and remained unchanged till the end of permanganate flush (44.7 h). The concentration of NaMnO₄ in the effluent progressively increased from 34 mg/L at 1 h to 3,828 mg/L at 22.4 h and remained more or less the same until 44.7 h. At this point, the eluent was changed from NaMnO₄ to uncontaminated groundwater (Cl⁻ = 154 mg/L) and the column flushed for about 29 h (from 44.7 h to 74.1 h). After starting the groundwater flush, the chloride concentration in the effluent rapidly rose to 144-148 mg/L and remained unchanged thereafter. At this point the test was terminated. The pH of the effluent in the beginning (at 1.2 h) was 6.2; it rose to 6.9 at 3.2 h and 7.3 at 20.5 h. The pH remained neutral to slightly alkaline thereafter. The initial low pH in the effluent may serve as additional evidence of oxidation of VC by permanganate since the mineralization of VC by permanganate results in a drop in pH and an increase in chloride content.

Post flushing analysis (Table 2) of soil both from top and bottom indicated 11 mg/kg and 9 mg/kg VC, respectively. The *cis*-1,2-DCE and TCE were also found in the soil samples obtained from the bottom (21 mg/kg and 14 mg/kg, respectively) and top (5 mg/kg and 6 mg/kg, respectively) of the column. Upon visual inspection of extruded soil core at the end of the test, it was noticed that the bottom half portion of the core was mostly comprised of white material with a brownish coating (most likely of precipitated manganese dioxide). It is clear from Table 2 that the concentration of VC in the bottom portion of soil core (that is essentially the white material) decreased by > 92% as a result of permanganate treatment flushing. This clearly indicates that although no appreciable change in the NaMnO₄ concentration was observed in the effluent beyond 22.4 h, the oxidation of VC (as well as

TCE and *cis*-1,2-DCE) was not complete. This behavior suggests that the white material may have highly porous structure (and hence high surface area) having strongly sorbed VC and other VOCs. If this was true then the persistence of VOCs after permanganate flushing through the white material may be explained based on slow mass transfer processes. Since the reaction between VC and NaMnO₄ is rapid, the slower mass transfer of target VOCs from the porous surface of white material into the pore water could limit this oxidation reaction. A longer contact time of NaMnO₄ with the white material could potentially solve this problem, if needed. The detection of VC, *cis*-1,2-DCE and TCE in the soil sample collected from the top of the core at the end of the test could be due to desorption of unreacted VOCs from the lower portion of the soil core during groundwater flushing followed by sorption on the upper portion of the soil core.

3.2.3 Control Column (C-2 test)

In order to assess the leaching behavior of VC from the white material during groundwater flushing, a column containing contaminated soil (C-2) was flushed with uncontaminated groundwater at a nominal flow rate of 0.24 mL (superficial velocity of 0.78 ft/d and a throughput of ~13.8 pore volumes per day). The groundwater was collected in 8 Tedlar bags from an uncontaminated area upgradient of the source area. A partial characterization of groundwater and soil used in this experiment is presented in Tables 1 and 2, respectively. A soil sample (that was essentially comprised of the white material) obtained from the bottom of the core showed 225 mg/kg VC, 41 mg/kg *cis*-1,2-DCE and 0.54 mg/kg TCE. These three VOCs were below detection limits (of 0.72 mg/kg) in the soil sample (that did not indicate the presence of any white material) obtained from the top of the soil core. The pH of the groundwater range between 6.9 and 7.4, and the chloride concentration was found to be between 136 mg/L to 151 mg/L.

During the course of the experiment, the effluent was analyzed for VC, pH and chloride. The concentration of VC and pH in the effluent vs. time is shown in Figure 11 (a). The concentration of chloride vs. time is shown in Figure 11 (b). It took about 54 min for the groundwater to first appear in the effluent. The first effluent sample collected at ~1 h showed a VC concentration of 11.8 mg/L. The VC concentration in the effluent steadily rose to ~25 mg/L after 51 h of flushing and then declined steadily to ~11 mg/L at 148 h and remained essentially unchanged for an additional 72 h. The VC concentration in the effluent continued to decrease beyond 220 h and dropped to ~4.7 mg/L at 405 h. The presence of VC in the effluent throughout the run may be attributed to the slow release of VC from the residual concentration on the white material.

The high VC associated with the white material is believed to be a result of the following: In the old manufacturing process for PVC one of the final steps involved heating the PVC material to desorb the residual vinyl chloride monomer. Typically, the VC content of the PVC material prior to desorption was in the range of 100 – 2000 mg/kg. It is likely that a few batches of inferior quality PVC may have been discarded undesorbed as fill material on this site. Historic photos indicate that this area of the site was filled between 1946 and 1982, the likely period of deposition of the white material tested in the study.

After flushing the contaminated soil column for nearly 405 h (~17 days) with ~ 5.8 L (230 pore volumes) of uncontaminated groundwater, the flushing was stopped and the column was allowed to drain under gravity. After removing the soil from the casing, samples were taken from the top, middle (white material) and bottom and analyzed for VOCs. No VC, *cis*-1,2-DCE and TCE were found in the soil sample collected from the top, however, the soil sample collected from the bottom end showed 6 mg/kg and 10 mg/kg of VC and *Cis*-1,2-DCE, respectively. It was surprising to find the presence of VC, *Cis*-1,2-DCE and TCE (219 mg/kg, 81 mg/kg and 38 mg/kg, respectively) in the white material even after passing ~230 pore volumes of groundwater through it. Since the initial concentrations of VOCs in the white material and the weight of white material in this column were unknown, a mass balance on VOCs could not be performed. However, it appears that the white material under site conditions may serve as a long term source of VC (and *Cis*-1,2-DCE and TCE).

4.0 CONCLUSIONS

The white material found at the site was identified as typical industrial PVC polymer. The white material is also found to be a primary source of vinyl chloride (most likely an unpolymerized VC sorbed on to the white material during the PVC polymerization process) in the groundwater. Findings from this screening study conducted to assess the feasibility of in-situ oxidation of vinyl chloride associated with the white material using sodium permanganate may be summarized as follows:

- The white material found at the site was identified as PVC polymer and was also found to be a source of vinyl chloride (a target parameter) and other chlorinated compounds (*Cis*-1,2-DCE and TCE). It appears that the residual chlorinated ethenes that are strongly sorbed by the white material are slowly leaching into the groundwater.
- Vinyl chloride, *Cis*-1,2-DCE and TCE concentrations as high as 2400 mg/kg, 370 mg/kg and 740 mg/kg, respectively, were found on the white material.
- The uncontaminated soil exhibited a relatively high oxidant demand of 13.5 g NaMnO₄/kg soil. However, this could be due to the silty nature of the soil and the relatively high natural organic content (TOC = 2.6%). It should be noted that the nature and texture of uncontaminated soil was much different than the contaminated soil and white material used in the column experiments. Thus, the actual SOD at the contaminated site may not be as high as determined in this experiment.
- A control column experiment (flushing of contaminated soil column with uncontaminated groundwater) that was ran for about 17 days indicated a continuous but slow release of VC from the white material into the groundwater. This phenomenon indicates the presence of residual and/or bound VC that is slowly desorbing from the white material into the groundwater through mass transfer processes.
- When the contaminated soil column was flushed with ~ 4.2 g/L NaMnO₄ solution at a linear velocity of 0.78 ft/d, no vinyl chloride was observed in the effluent, indicating a rapid oxidation of VC by NaMnO₄. However, detection of low concentrations of VC and *Cis*-1,2-DCE in the soil after flushing with NaMnO₄ followed by uncontaminated

groundwater flushing indicates that a longer contact time between NaMnO_4 and the white material may be necessary for complete destruction of target contaminants. Although low levels of VC and *Cis*-1,2-DCE were found in the soil after permanganate flushing, these levels were below MCP UCL for VC (20 mg/kg) and *Cis*-1,2-DCE (1000 mg/kg).

Overall, the oxidation of VC associated with the white material using NaMnO_4 at the Solutia site appears to be a promising technology for an in-situ site cleanup. Therefore, it is highly recommended to conduct a small pilot test prior to applying this technology on a full scale at the site.

Table 1. Partial characterization of uncontaminated ground water (obtained from MW 95S).

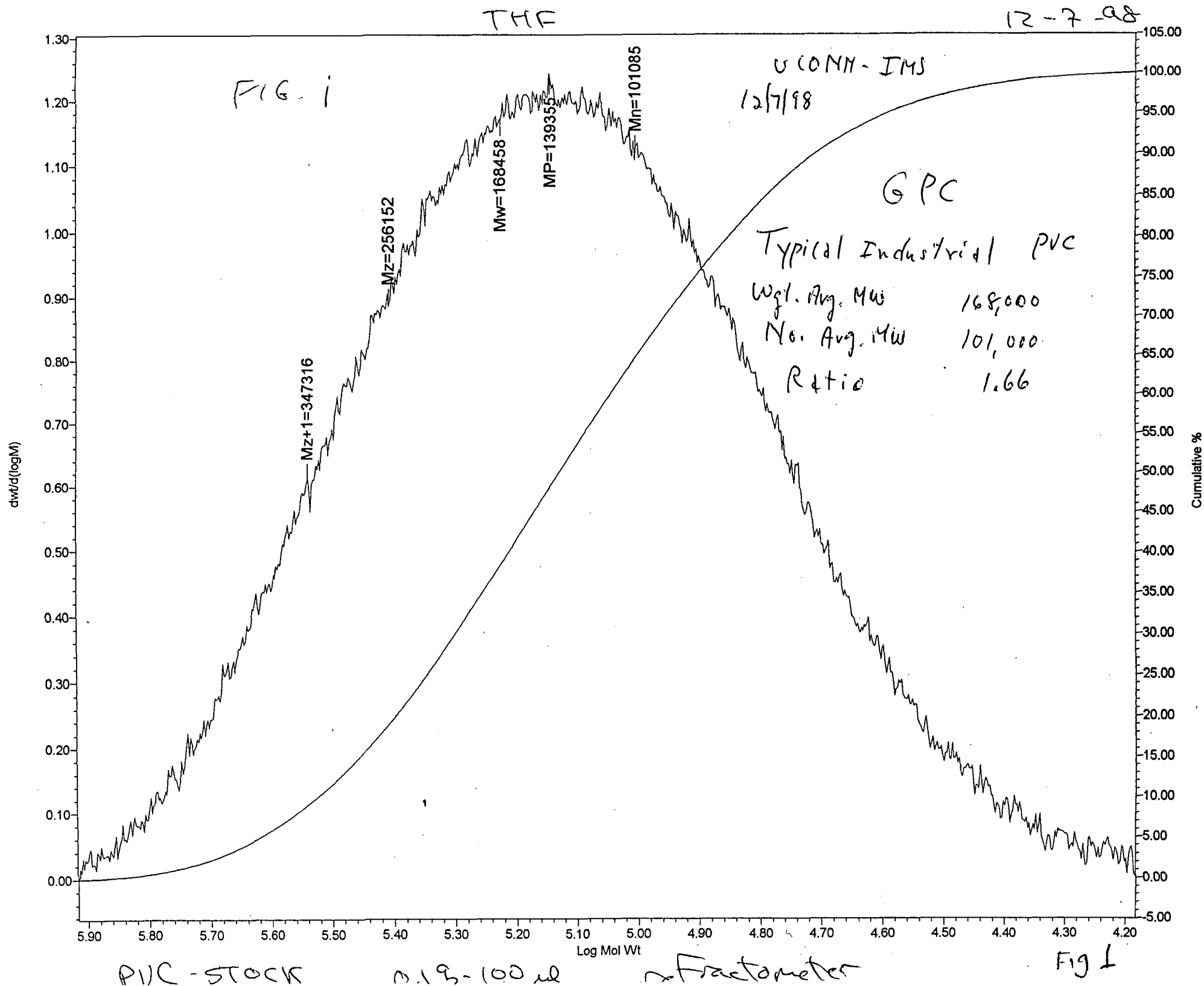
Parameter	Detection Limits	Concentration					
		Bag #1	Bag #3	Bag #4	Bag #5	Bag #6	Bag #7
pH		6.9	7.2	7.0	6.9	7.2	7.4
Chloride, mg/L	0.1	143	136	151	147	147	151
Vinyl Chloride, µg/L	2	*BDL	*BDL	BDL*	*BDL	*BDL	*BDL

*BDL-Below Detection Limit

Table 2. Concentrations of various parameters in soil (before and after test) used for the column experiments.

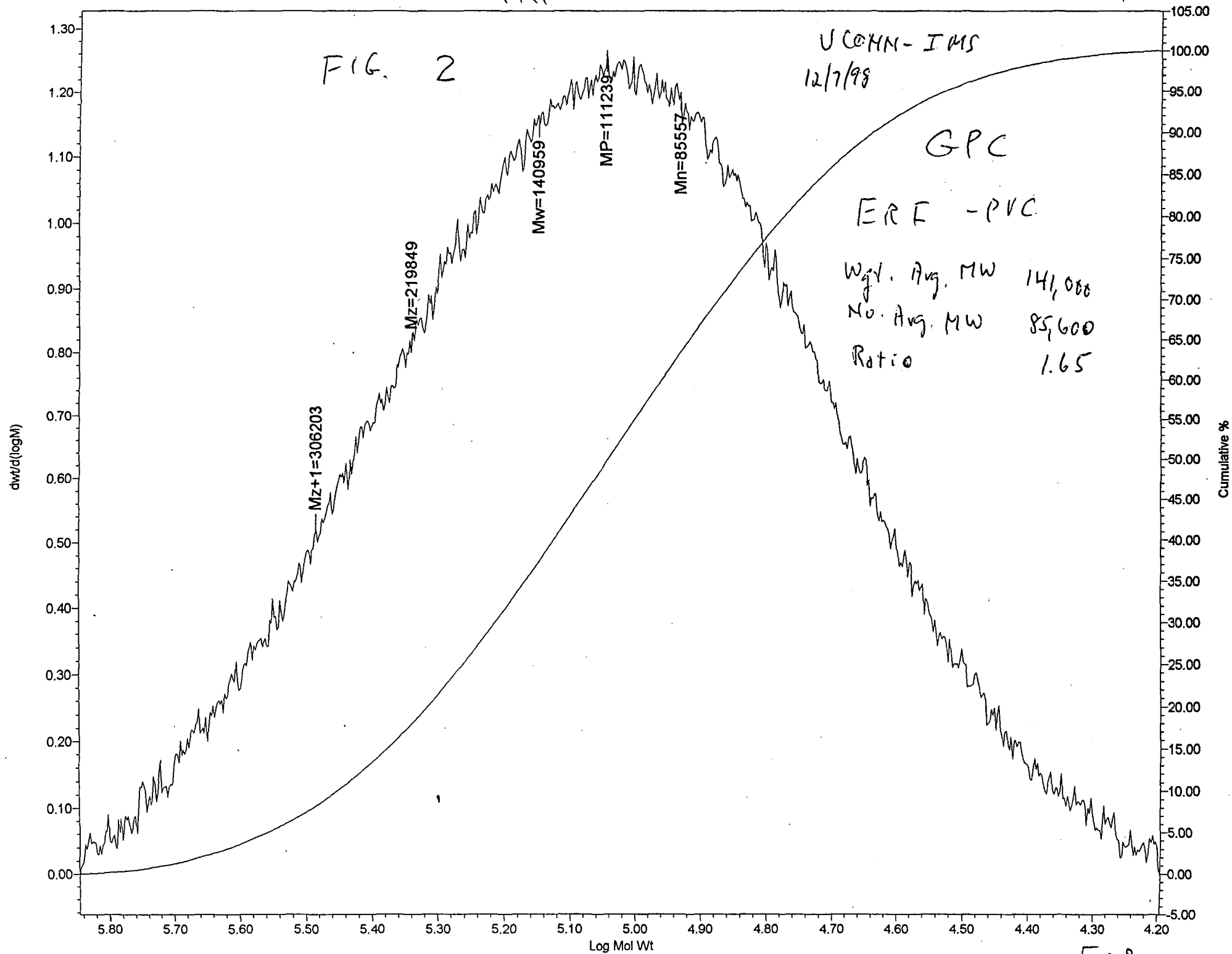
Parameter	Uncontaminated Column (UC-1) + NaMnO ₄		Contaminated Column (C-1) + NaMnO ₄				Contaminated Column (C-2) + Uncontaminated Ground Water (Control)				
	Before Test		Before Test		After Test		Before Test		After Test		
	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	White Material	Bottom
pH		7.0		7.0				7.4			
Alkalinity, g CaCO ₃ /kg		259		232				266			
Moisture Content, %	6	13	5	14	21	41	14.4	13.7	13	40	20
VOCs, mg/kg											
Vinyl Chloride	0.07	0.001	*BDL	118	11	9	*BDL	225	*BDL	219	6
<i>Cis</i> -1,2-Dichloroethene	*BDL	*BDL	*BDL	77	5	21	*BDL	41	*BDL	81	10
Trichloroethene	0.005	*BDL	*BDL	*BDL	6	14	*BDL	*BDL	*BDL	38	*BDL
Detection Limits											
VOCs, mg/kg	0.001	0.001	6	35	3	6	1	1	4	7	4
Alkalinity, g CaCO ₃ /kg		4		4				4			

*BDL-Below Detection Limit. *Sample primarily comprised of white material. Note: MCP UCL's for VC and *cis*-1,2-DCE are 20 mg/kg and 1,000 mg/kg.



THF

12-7-98



PVC-ERI

0.1g-100ul

refractometer

Fig 2

Sample: ERI PVC SAMPLE
Size: 31.5700 mg
Method: RAMP20T0700 JAH 09/02/98
Comment: 20/min to 700, hold at 100

TGA

File: C:TMS-T.119
Operator: TMS
Run Date: 7-Dec-98 11:24

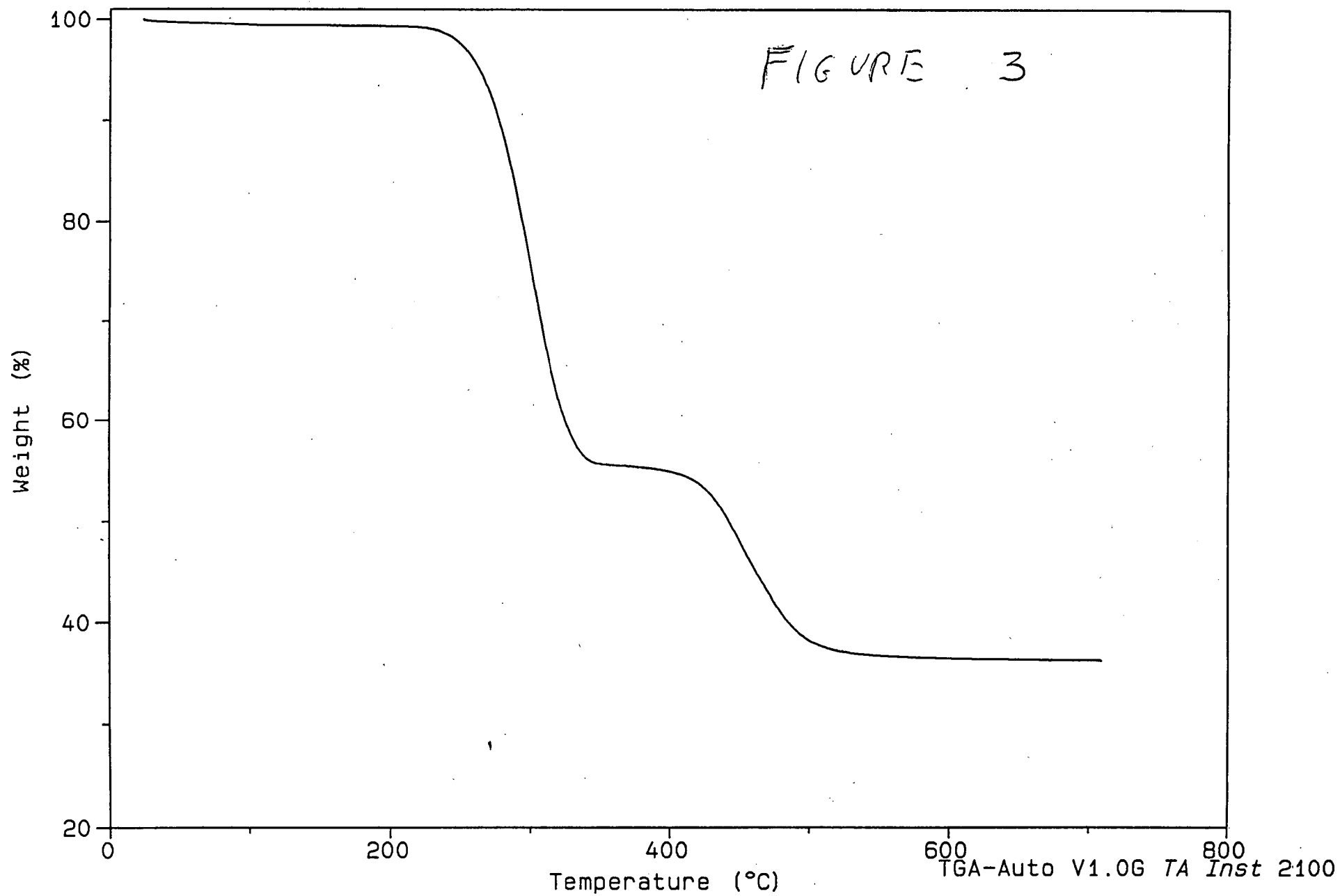


Fig. 3

Sample: PVC STANDARD (KNOWN PVC)
Size: 8.4430 mg
Method: RAMP20T0155 JAH06/18/98
Comment: ROOM TO 150C

1H K DSC

File: C:TMS-B.407
Operator: TMS
Run Date: 7-Dec-98 13:13

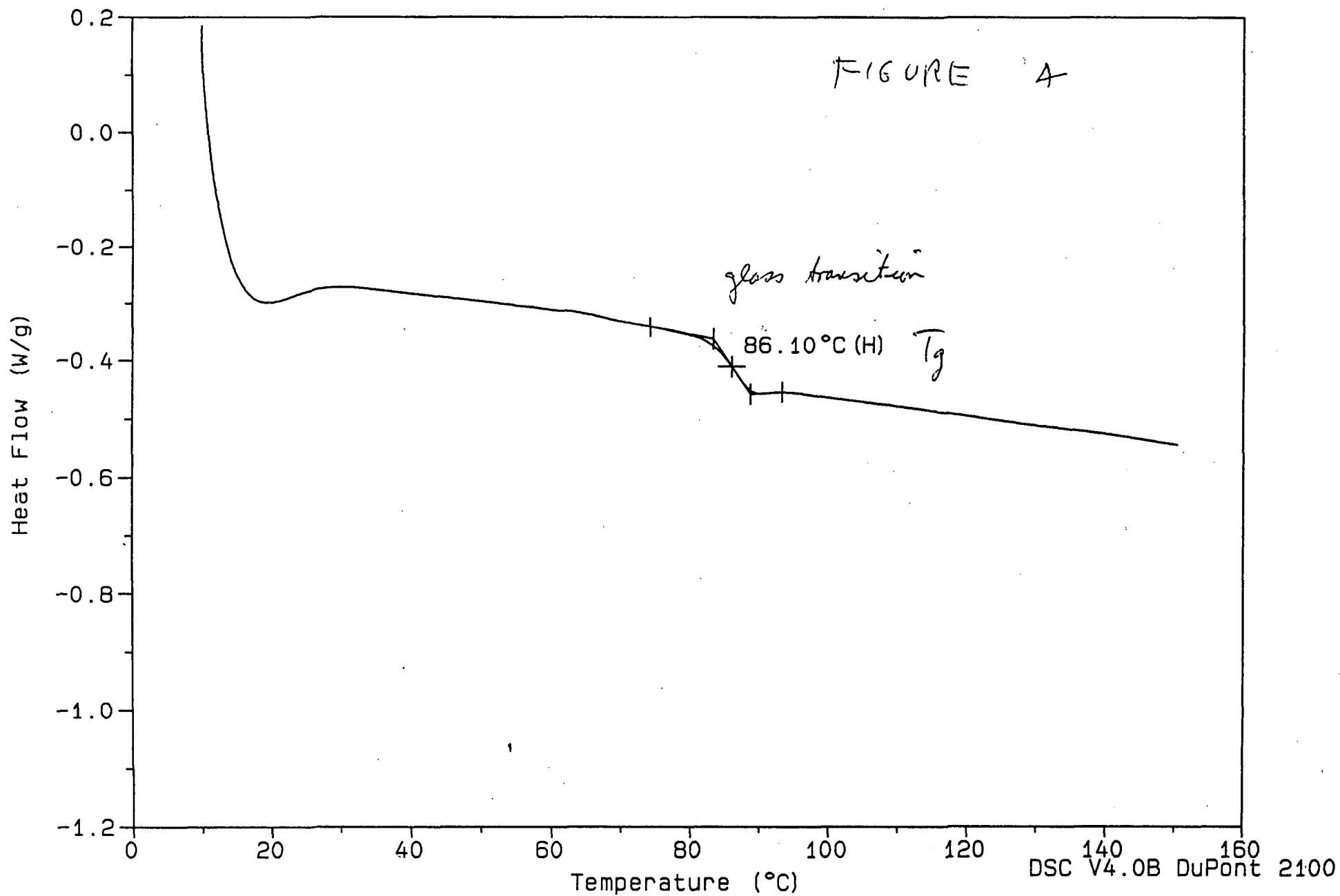


Fig 4

Sample: ERI PVC SAMPLE

Size: 7.2750 mg

Method: RAMP20T0155 JAH06/18/98

Comment: ROOM TO 150C

1H J DSC

File: C:TMS-B.406

Operator: TMS

Run Date: 7-Dec-98 13:13

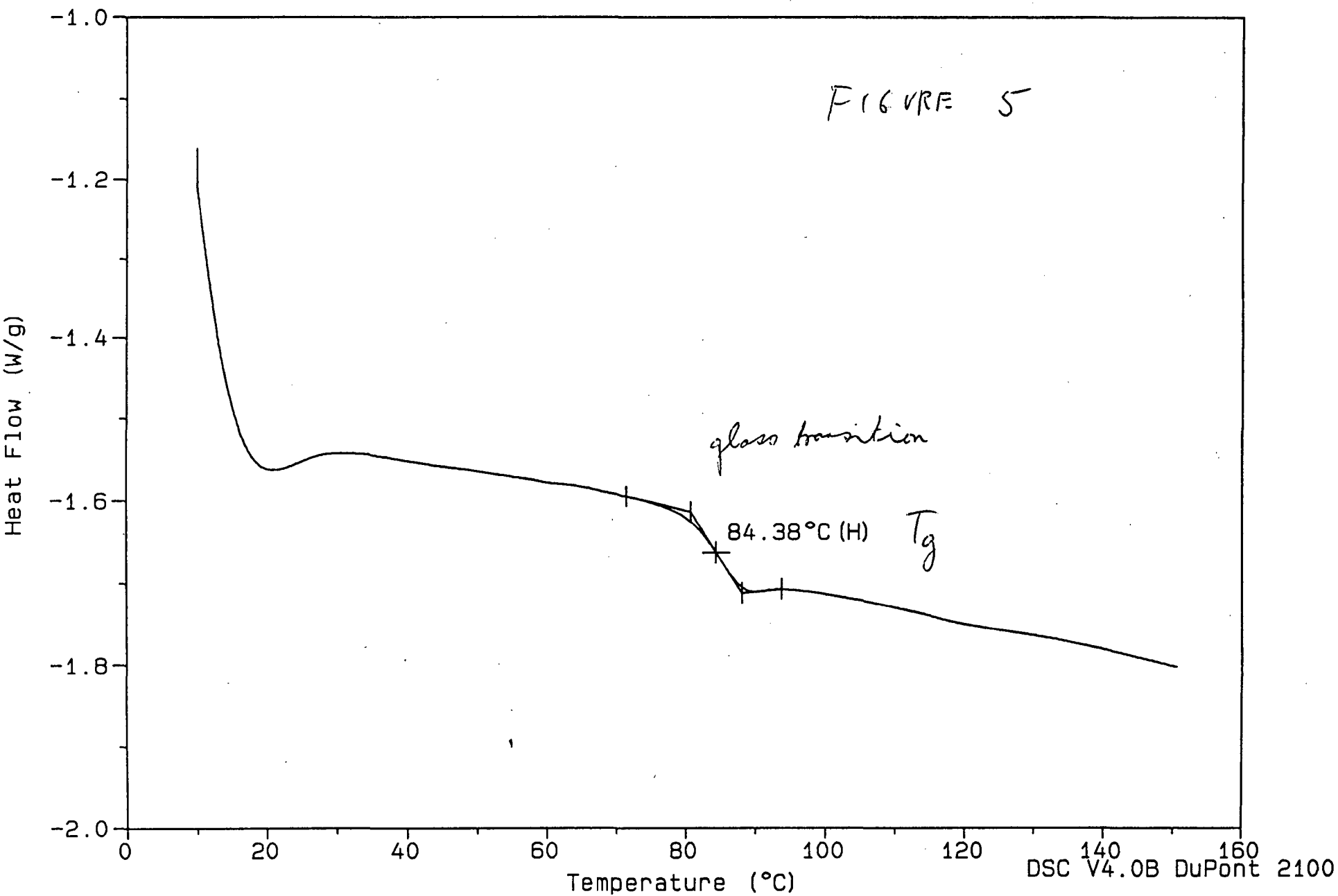


Fig 5

Technique: KBr WAFER
Source of Sample: ALDRICH CHEMICAL COMPANY, INC.
Classification: Polymers: VINYL CHLORIDE HOMOPOLYMERS

FIG 6

INFRARED SPECTROSCOPY

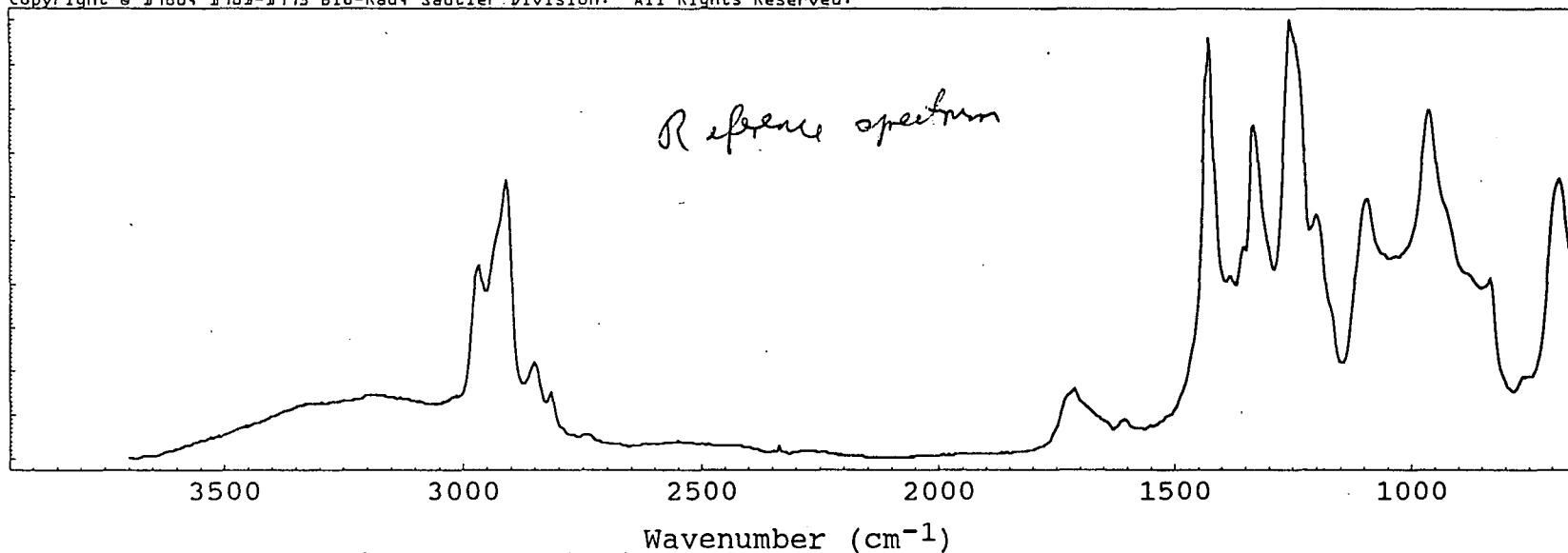
UConn - IMS

POLYVINYL CHLORIDE

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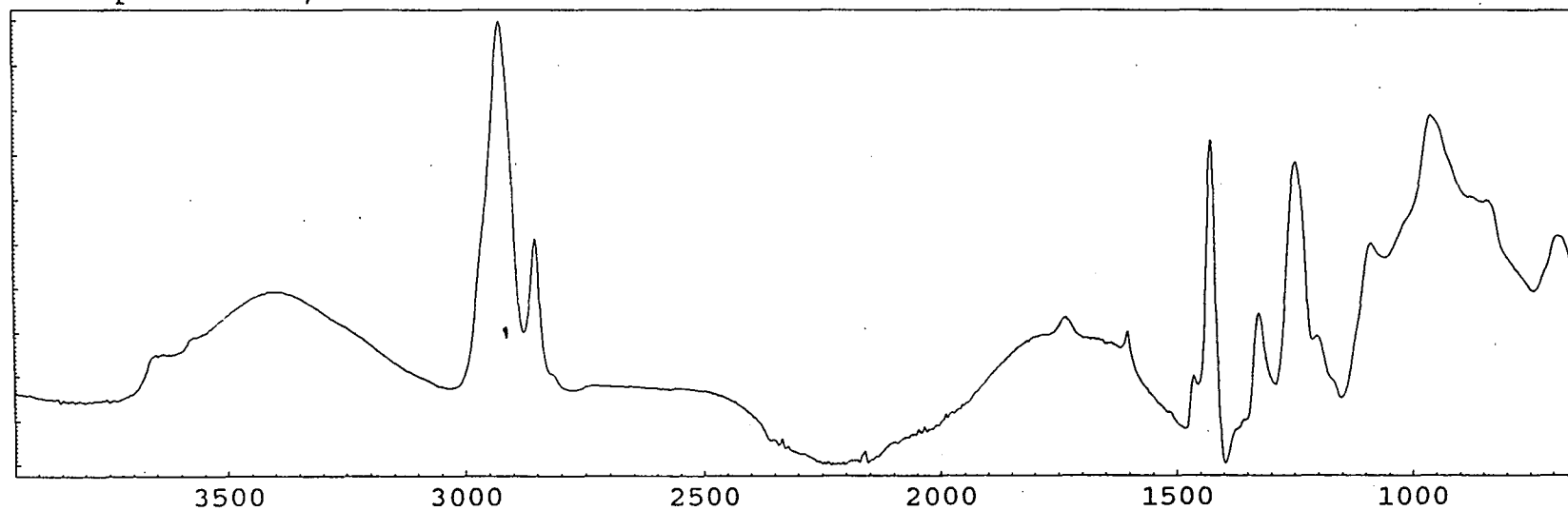
A
B
S
O
R
B
A
N
C
E

Reference spectrum



white powder ERI, micro transmission

A
B
S
O
R
B
A
N
C
E



Wavenumber (cm⁻¹)

13:50:33 12/04/98
Gary Lavigne

Fig 6

File : C:\HPCHEM\1\DATA\WPERI.D
Operator : Gary Lavigne
Acquired : 4 Dec 98 1:57 pm using AcqMethod 300JW01
Instrument : GC/MS Ins
Sample Name: White powder ERI 1.77mg 300C 2m
Misc Info : 35 to 325 at 15 deg./min 2 min hold at 35C
Vial Number: 1

U COMM-IMS

2 minutes 300°C

FIG # 7

THERMAL DESORPTION GC/MS

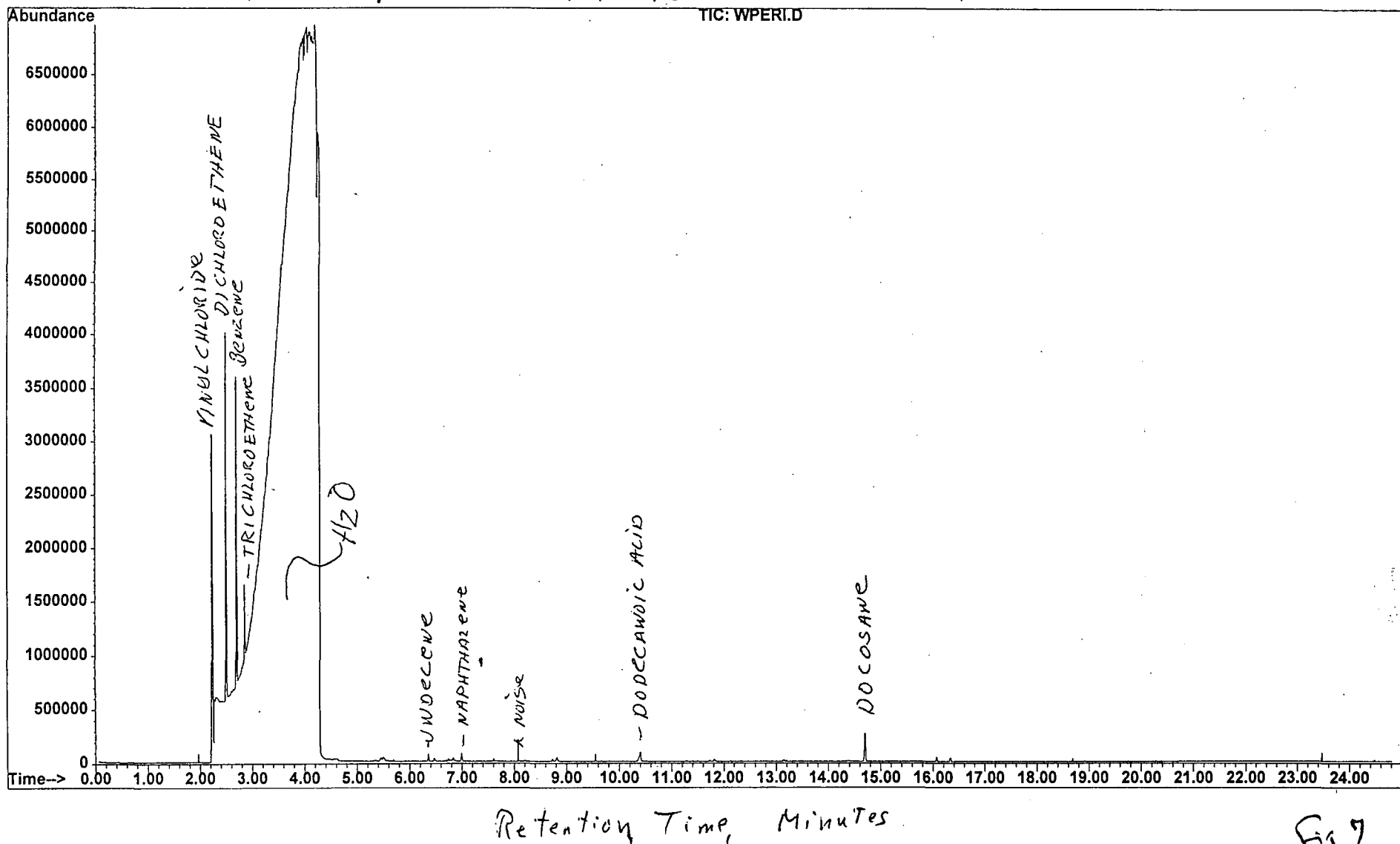
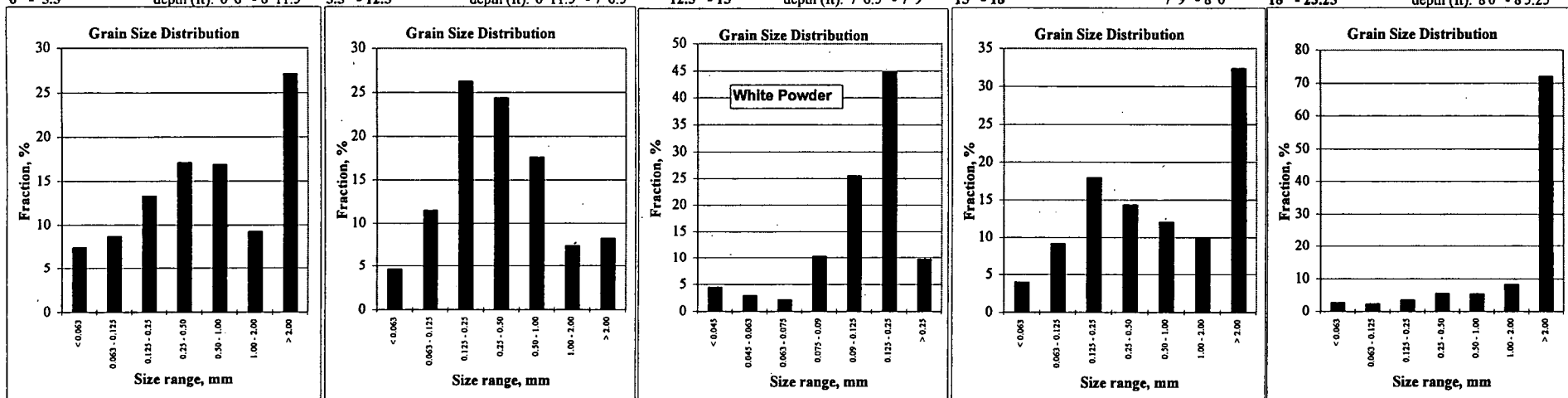
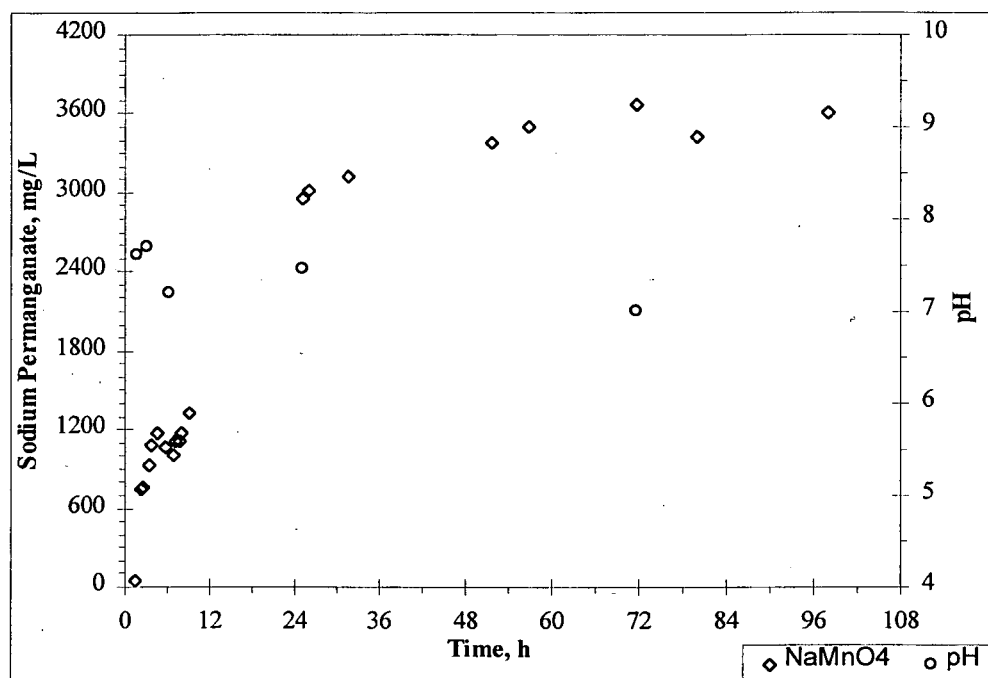


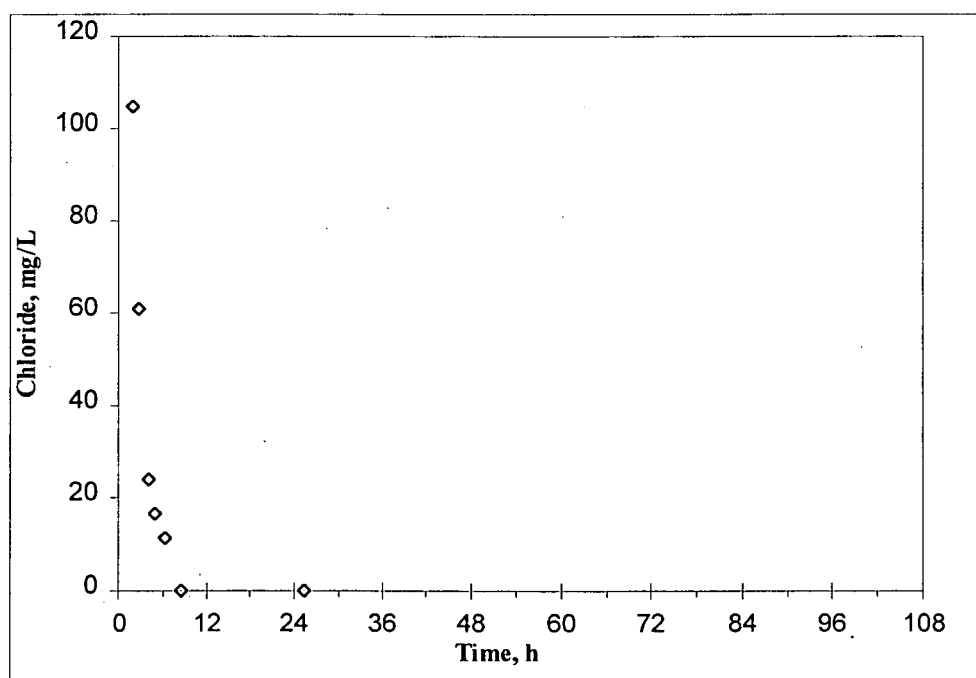
Fig 7

Figure 8 Grain size distribution for 5 subsamples of the soil core (SB-91) obtained at a depth from 6'6" to 8'5.25"





(a)



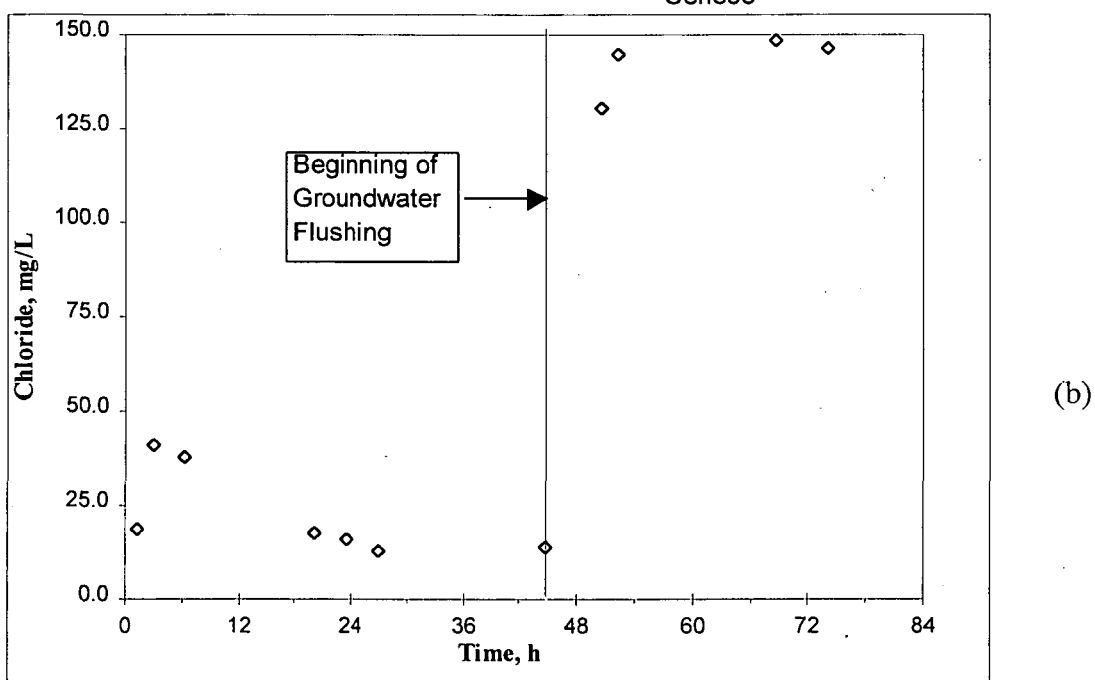
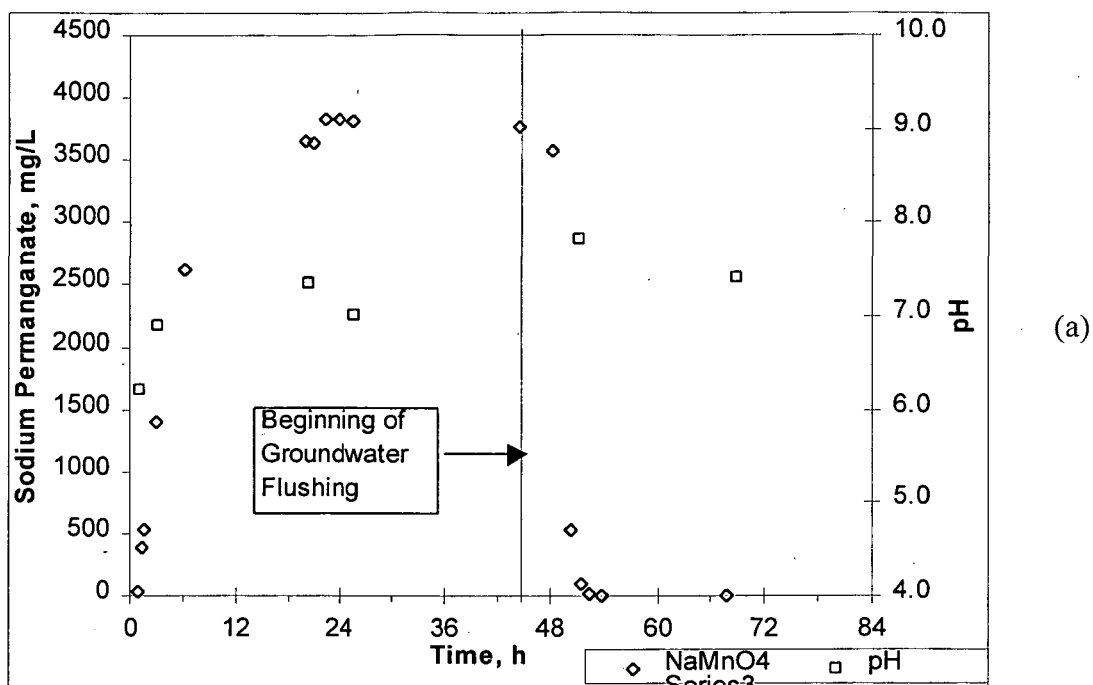
(b)

Experimental Conditions:

Reactor: 43 mm dia x 7 cm long, stainless steel column containing uncontaminated soil.

Influent: $[\text{NaMnO}_4]_{\text{in}} \sim 4,160 \text{ mg/L}$ at 0.29 mL/min

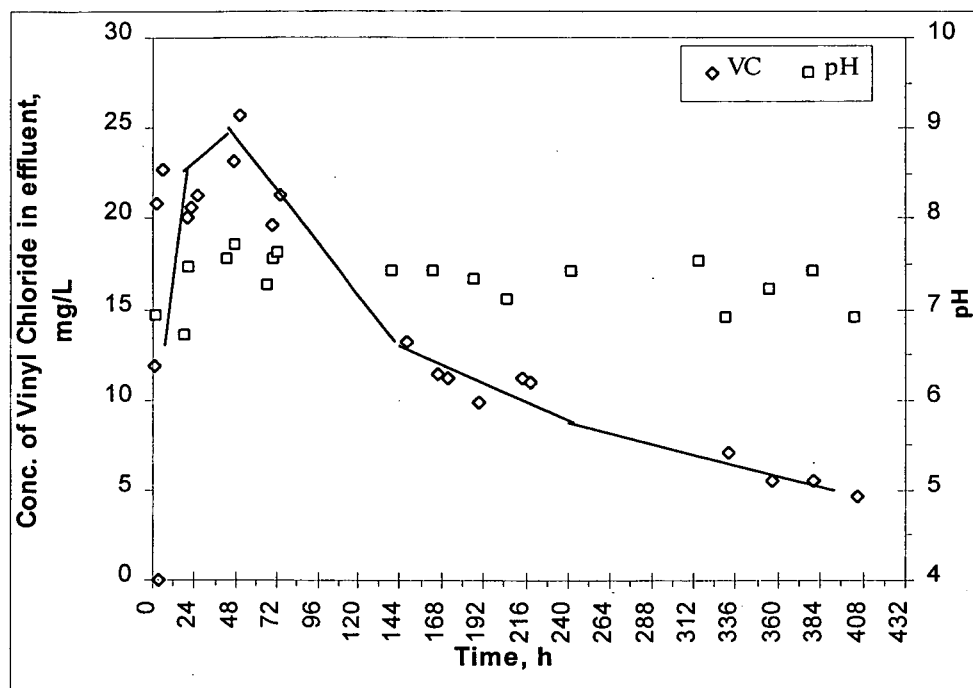
Figure 9. Estimation of an oxidant demand of an uncontaminated soil for NaMnO_4 : (a) changes in oxidant concentration and pH in the effluent with time, (b) changes in chloride concentration in the effluent with time.



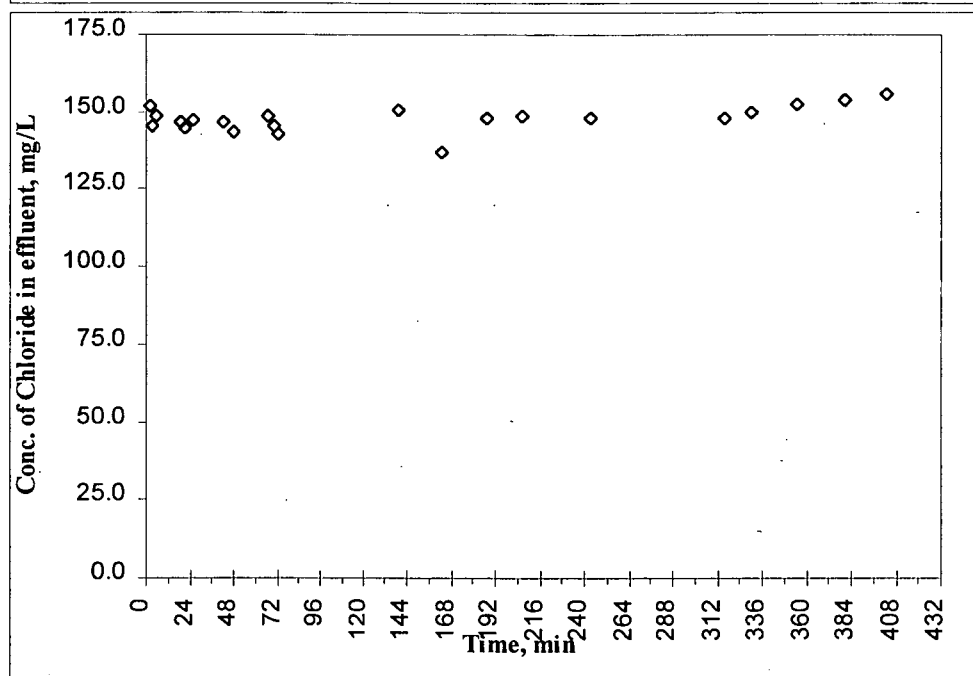
Experimental Conditions:

Reactor: 43 mm dia x 7 cm long, stainless steel column containing contaminated soil.
 Influent: $[\text{NaMnO}_4]_{\text{in}} \sim 4,200 \text{ mg/L}$, followed by uncontaminated groundwater at 0.25 mL/min, $\text{Cl}^- (\text{in GW})_{\text{in}} = 143 \text{ mg/L}$

Figure 10. In-situ oxidation of VC in contaminated soil containing white material using NaMnO_4 : (a) changes in oxidant concentration and pH in the effluent with time, (b) changes in chloride concentration in the effluent with time.



(a)



(b)

Experimental Conditions:

Reactor: 43 mm dia x 7 cm long, stainless steel column containing contaminated soil.

Influent: Uncontaminated GW at 0.24 mL/min, Cl^- (in GW) = 136-151 mg/L

Figure 11. Continuous flushing of contaminated soil containing white material with uncontaminated groundwater: (a) vinyl chloride concentration and pH in the effluent with time, (b) changes in chloride concentration in the effluent with time.

APPENDIX I

Raw Data and Experimental Conditions

Experiment # UC-1**Column Study : Soil Core (SB-106: 6' 7.5" ~ 6' 10.5") from Solutia****Study of Soil Oxidant Demand for Sodium Permanganate**

Purpose: 1. Evaluate the soil NaMnO₄ demand.

Experimental Conditions:

(Reactor Type : 4.3 mm dia x 7 cm long Stainless Steel Column)

Inlet NaMnO₄ Conc. = 4160 mg/L
 Total volume passed = 1714 mL
 Total time = 5881 min
 Flow rate = 0.29 mL/min
 Weight of soil wet = 181.96 g
 Moisture = 9.5%
 Weight of soil dry = 164.7 g

Before

VC in soil (top), µg/g = 0.069
 VC in soil (bottom), µg/g = 0.001
 (c)1,2-DCE in soil (top), µg/g ND
 (c)1,2-DCE in soil (bottom), µg/g ND
 TCE in soil (top), µg/g ND
 TCE in soil (bottom), µg/g ND

Method:

Uncontaminated soil core (SB106 6' 7.5" ~ 6' 10.5") was used in this experiment. A concentration of 4160 mg/L NaMnO₄ was used to flush the column. The flow rate was controlled at 0.29 mL/min by a peristaltic pump which is with 8 rollers to minimum the pulse flow. The NaMnO₄ concentrations of influent and effluent were measured. Effluent was analyzed for Cl⁻, VOCs and pH value. Organic Carbon by Thermal Combustion 2.6%

Results

Began Column Study at 8 a.m. on 12/18/98

Time Range, Min		Interval min	Time h	NaMnO4 mg/L	Conc. in Effluent		
initial	final				VC mg/L	Cl- mg/L	pH
At 80 min. began to elute from the column							
80	83	3	1.4	52			
83	108	25	1.6		N		7.6
111	136	25	2.1			104.6	
136	145	9	2.3	740	O		
145	156	11	2.5	765			
156	182	26	2.8		T	60.8	
182	200	18	3.2				7.7
200	211	11	3.4	933			
211	225	14	3.6	1075	A		
225	262	37	4.1			23.9	
262	271	9	4.4	1170	P		
271	319	48	4.9			16.6	
319	350	31	5.6	1063	P		
350	414	64	6.4			11.3	7.2
414	423	9	7.0	998	L		
423	444	21	7.2	1116			
444	466	22	7.6	1105	I		
466	502	36	8.1	1167			
502	532	30	8.6		C	0.0	
532	563	31	9.1	1323			
1500	1509	9	25.1		A		7.5
1509	1519	10	25.2	2948			
1519	1531	12	25.4		B	0.0	
1553	1563	10	26.0	3013			
1887	1910	23	31.6	3113	L		
3090	3120	30	51.8	3379			
3398	3428	30	56.9	3497	E		
4295	4307	12	71.7	3663			7
4782	4811	29	79.9	3427			
5871	5881	10	97.9	3604			

Experiment # C-1**Column Study : Soil Core (SB-104A: 6' 5.75" ~ 6' 8.75") from Solutia
Study of Soil NaMnO4 Demand****Purposes:** 1. Evaluate the effectiveness of NaMnO4 for the insitu oxidation of vinyl chloride**Experimental Conditions:**

(Reactor Type : 4.3 mm dia x 7 cm long Stainless Steel Column)

		Before	After
Inlet NaMnO4 Conc. = 4200	mg/L	VC in soil (top), µg/g < 5.59	= 11.50
Total volume passed = 1110	mL	VC in soil (bottom), µg/g = 118	= 9.44
Total time = 4458	min	(c)1,2-DCE in soil (top), µg/g < 5.59	= 4.90
Flow rate = 0.25	mL/min	(c)1,2-DCE in soil (bottom), µg/g = 77	= 20.71
Weight of soil wet = 154.1	g	TCE in soil (top), µg/g < 5.59	= 6.38
Moisture = 9.6%		TCE in soil (bottom), µg/g < 33.49	= 13.89
Weight of soil dry = 139.3	g		

Methods: Soil core (SB-104A 6' 5.75" ~ 6' 8.75") was used in this experiment. A concentration of 4160mg/L NaMnO4 was used to flush the column. The flow rate was controlled at 0.25 mL/min by a peristaltic pump which is with 8 rollers to minimum the pulse flow. The NaMnO4 concentrations of influent and effluent were measured. Effluent was also analyzed for Cl⁻, VOCs and pH value. MW 95S Bag #1 was used as inlet ground water (pH = 7.2, Cl⁻ =143 mg/L)

Results**Began Column Study on 12/28/98**

Results

Began Column Study on 12/20/76

Time Range, Min		Interval min	Time h	Conc. in Effluent			
initial	final			NaMnO4 mg/L	VC mg/L	Cl- mg/L	pH
At 36 min. began to elute from the column							
38	40	2	0.7		nd		
54	66	12	1.0	34			
66	72	6	1.2				6.2
72	84	12	1.3			18.9	
84	94	10	1.5	384			
94	105	11	1.7	526			
160	160	0	2.7		nd		
170	180	10	2.9	1403			
180	189	9	3.1			41.1	
189	198	9	3.2				6.9
360	390	30	6.3	2623	nd	38.0	
1192	1202	10	20.0	3645			
1202	1219	17	20.2			17.7	
1219	1239	20	20.5				7.3
1239	1254	15	20.8	3639			
1299	1299	0	21.7		nd		
1336	1350	14	22.4	3828			
1396	1416	20	23.4			15.9	
1416	1440	24	23.8	3817			
1526	1543	17	25.6	3805			
1543	1558	15	25.8				7.0
1608	1620	12	26.9			12.6	
2663	2673	10	44.5	3757			
2673	2691	18	44.7			14.0	
Switch to Groundwater							
2745	2745	0	45.8		nd		
2880	2901	21	48.2	3568			
3010	3026	16	50.3	526			
3026	3047	21	50.6			130.5	
3056	3085	29	51.2				7.8
3085	3105	20	51.6	96			
3120	3138	18	52.2			144.6	
3138	3138	0	52.3		nd		
3138	3154	16	52.4	24			
3218	3239	21	53.8	3			
4056	4069	13	67.7	nd			
4113	4132	19	68.7			148.6	
4133	4147	14	69.0				7.4
4260	4260	0	71.0		nd		
4440	4458	18	74.2			146.3	
4445	4445	0	74.1		nd		

nd = Non detect

of samples

17

8

11

6

Experiment # C-2**Column Study : Soil Core (SB-105A: 6' 3.75" ~ 6' 6.75") from Solutia****Study of leaching potential of vinyl chloride from white powder (Control)**

Purposes: 1. Evaluate the leaching characteristics of vinyl chloride from white powder

Experimental Conditions:

(Reactor Type : 4.3 mm dia x 7 cm long Stainless Steel Column)

		<u>Before</u>	<u>After</u>
MW 95S Bag #4 Inlet G.W. pH. = 7.0		VC in soil (top), µg/g < 1	< 4
MW 95S Bag #4 Inlet G.W. Cl ⁻ = 151 mg/L		VC in powder (middle), µg/g -	= 219
MW 95S Bag #4 Inlet G.W. VC nd µg/L		VC in soil (bottom), µg/g = 225	= 6
MW 95S Bag #3 Inlet G.W. pH. = 7.2		(c)1,2-DCE in soil (top), µg/g < 1	< 4
MW 95S Bag #3 Inlet G.W. Cl ⁻ = 136 mg/L		(c)1,2-DCE in powder (middle), µg/g -	= 81
MW 95S Bag #3 Inlet G.W. VC nd µg/L		(c)1,2-DCE in soil (bottom), µg/g = 41	= 10
Total time = 24175 min		TCE in soil (top), µg/g < 1	< 4
Flow rate = 0.24 mL/min		TCE in powder (middle), µg/g -	= 38
Weight of soil wet = 167 g		TCE in soil (bottom), µg/g < 1	< 4
Moisture = 14.0%			
Weight of soil dry = 144 g			

Methods:

Soil core (SB-105A 6' 3.75" ~ 6' 6.75") was used in this experiment. MW 95S bag #4 and #3 were used in this experiment. The flow rate was controlled at 0.24 mL/min by a peristaltic pump which is with 8 rollers to minimum the pulse flow. Effluent was analyzed for Cl⁻, VOCs and pH value.

Results

Began Column Study at 1 p.m. on 1/5/99

Time Range, Min		Interval min	Time h	Conc. in Effluent		pH
initial	final			VC mg/L	Cl- mg/L	
At 54 min. began to elute from the column						
54	71	17	1.0	11.8		
97	114	17	1.8		151.6	
142	142	0	2.4	20.8		
234	234	0	3.9			
165	180	15	2.9			6.9
212	229	17	3.7		145.2	
284	320	36	5.0		148.8	
325	325	0	5.4	22.6		
1099	1115	16	18.5		146.8	
1120	1140	20	18.8			6.7
1220	1220	0	20.3	20.1		
1298	1296	-2	21.6		144.9	
1296	1313	17	21.7			7.5
1355	1355	0	22.6	20.6		
1527	1550	23	25.6		147.5	
1575	1575	0	26.3	21.2		
2555	2570	15	42.7		146.4	
2570	2595	25	43.0			7.6
2820	2820	0	47.0	23.2		
2857	2876	19	47.8		143.6	
2876	2892	16	48.1			7.7
3060	3060	0	51.0	25.7		
3975	3996	21	66.4		148.3	
3996	4014	18	66.8			7.3
4140	4140	0	69.0	19.5		
4205	4230	25	70.3		145.4	
4230	4250	20	70.7			7.6
4360	4379	19	72.8		142.7	
4379	4393	14	73.1			7.6
4440	4440	0	74.0	21.3		

Experiment C-2 (Cont...)

Time Range, Min		Interval min	Time h	Conc. in Effluent		pH
initial	final			VC mg/L	Cl- mg/L	
8340	8365	25	139.2		150.2	
8365	8383	18	139.6			7.4
8880	8880	0	148.0	13.2		
9930	9930	0	165.5	11.4		
9774	9792	18	163.1		136.8	
9792	9817	25	163.4			7.4
10290	10290	0	171.5	11.2		
11212	11233	21	187.0		148.0	
11233	11246	13	187.3			7.3
11340	11340	0	189.0	9.9		
12356	12380	24	206.1		148.5	
12380	12402	22	206.5			7.1
12825	12825	0	213.8	11.1		
13160	13160	0	219.3	11.0		
14570	14570	0	242.8		147.7	7.4
18921	18945	24	315.6		147.6	7.5
19850	19864	14	331.0		150.1	
19864	19882	18	331.2			6.9
19950	19950	0	332.5	7.0		
21287	21305	18	354.9		152.6	
21305	21322	17	355.2			7.2
21420	21420	0	357.0	5.6		
22814	22814	0	380.2	5.5	153.8	7.4
24172	24192	20	403.0		155.8	
24192	24205	13	403.3			6.9
24270	24270	0	404.5	4.7		

APPENDIX II

Summary of PVC Manufacturing Process

Principles of — Polymerization —

SECOND EDITION

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1981

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temperature, the pH adjusted to dissolve the surfactant and the polystyrene beads separated, washed with water and dried.

Polystyrene (PS) as commercially produced has an $\bar{M}_n$ in the range 50,000–300,000. Although completely amorphous ($T_g = 85^\circ\text{C}$), its bulky rigid chains impart good strength with high-dimensional stability (only 1–3% elongation); polystyrene is a typical rigid plastic. Polystyrene is a good electrical insulator, has excellent optical clarity due to the lack of crystallinity, and is easy to process since only T_g must be overcome for the polymer to flow. However, polystyrene has a number of deficiencies. It is attacked by organic solvents, has poor weatherability (UV and oxygen attack) due to the benzylic hydrogens, is brittle, and has poor impact strength due to the stiff polymer chains (a consequence of phenyl-phenyl interactions). The upper temperature limit for using polystyrene is low (limited by T_g) due to the lack of crystallinity. In spite of these defects, styrene polymers are used extensively, over 4 billion pounds of plastics and over 3 billion pounds of elastomers per year in the United States [288]. The deficiencies of polystyrene are overcome by copolymerization (Sec. 6-8a) with other monomers (acrylonitrile and butadiene) and by physically blending (mixing) with other polymers. Polymeric products containing styrene are used in a wide range of applications [288]. Elastomer uses include tires, hose, belting, shoes, coated fabrics, and electrical insulation. Plastic applications include packaging film, auto parts, containers, luggage, toys, drain and waste pipe, refrigerator liners, foamed products (coolers and coffee cups), and TV cabinets.

Trade names for PS include *Lustrex*, *Hostyren*, *Styrocell*, and *Styrofoam*.

3-13b-3 Vinyl Family

The *vinyl* family of polymers, consisting of poly(vinyl chloride), poly(vinyl acetate), poly(vinylidene chloride), their copolymers and derived polymers, are produced to the extent of about 7 billion pounds annually in the United States.

3-13b-3-a Poly(vinyl chloride). Most poly(vinyl chloride) (referred to as *PVC*) is commercially produced mainly by suspension polymerization. Bulk and emulsion



polymerizations are used to a lesser extent and solution polymerization is seldom used [278–280,282]. Suspension polymerization of vinyl chloride is generally carried out batchwise in a stirred reactor such as that shown in Fig. 3-24. A typical recipe includes 180 parts water, 100 parts vinyl chloride, 0.5 part poly(vinyl alcohol) and 0.03 part sodium isobutylphenylsulfonate as dispersants, and 0.5 part lauroyl peroxide [289]. A chain transfer agent such as trichloroethylene may also be present. All components except monomers are charged into the vessel, which is then partially evacuated. Vinyl chloride is then drawn in, sometimes by using pressurized oxygen-free nitrogen to force monomer into the reactor. The

Process Conditions

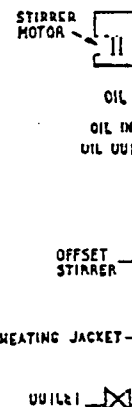


Fig. 3-24 Typical polymerization reactor [270] (by permission of)

reactants are then heated to about 0.5 MPa. The reaction proceeds. When the reaction reaches 90% conversion, the mixture is cooled, and the reactor is vented to air at about 100°C . The number-average molecular weight is about 80,000.

Poly(vinyl chloride) is unstable to heat and light (due to the bulky substituents). This is apparent in processing by a variety of methods. It is unstable to heat and light, and has deleterious effects on health as well as physiological effects. PVC is stabilized by adding stabilizers with the evolved HCl.

the polystyrene beads

in the range 50,000-
is bulky rigid chains
ly 1-3% elongation);
electrical insulator, has
easy to process since
ver, polystyrene has a
is poor weatherability
brittle, and has poor
nce of phenyl-phenyl
ylene is low (limited
acts, styrene polymers
over 3 billion pounds
encies of polystyrene
monomers (acrylo-
with other polymers.
range of applications
ed fabrics, and electri-
uto parts, containers,
ed products (coolers

d Styrofoam.

), poly(vinyl acetate),
ymers, are produced
States.

ferred to as PVC) is
1. Bulk and emulsion

(3-219)

merization is seldom
chloride is generally
1 Fig. 3-24. A typical
0.5 part poly(vinyl
dispersants, and 0.5
chloroethylene may
rge into the vessel,
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to the reactor. The

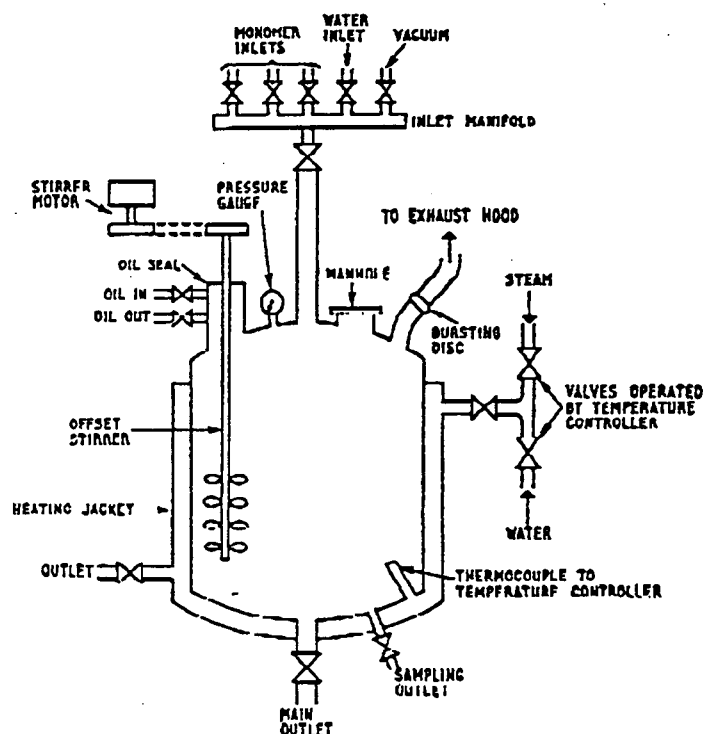


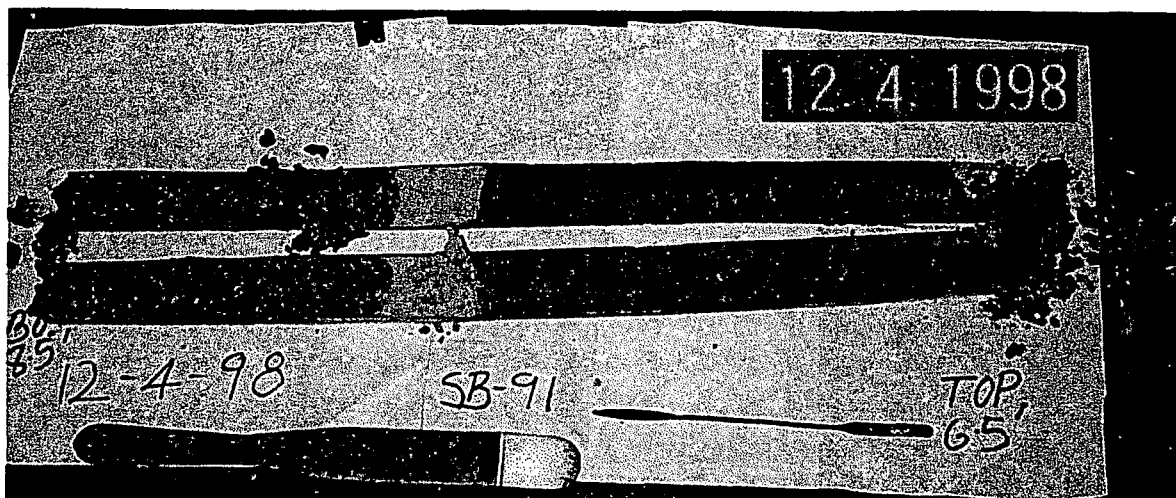
Fig. 3-24 Typical polymerization vessel suitable for suspension polymerization of vinyl chloride [278] (by permission of Van Nostrand Reinhold, New York).

reactants are then heated in a closed system to about 50°C and the pressure rises to about 0.5 MPa. The temperature is maintained at about 50°C as polymerization proceeds. When the pressure decreases to about 0.05 MPa (corresponding to about 90% conversion), excess monomer is vented off to be recycled. The reaction mixture is cooled, and the polymer separated (usually by centrifugation), dried in hot air at about 100°C, sieved to remove any oversized particles and stored. Typical number-average molecular weights for commercial PVC are in the range 30,000-80,000.

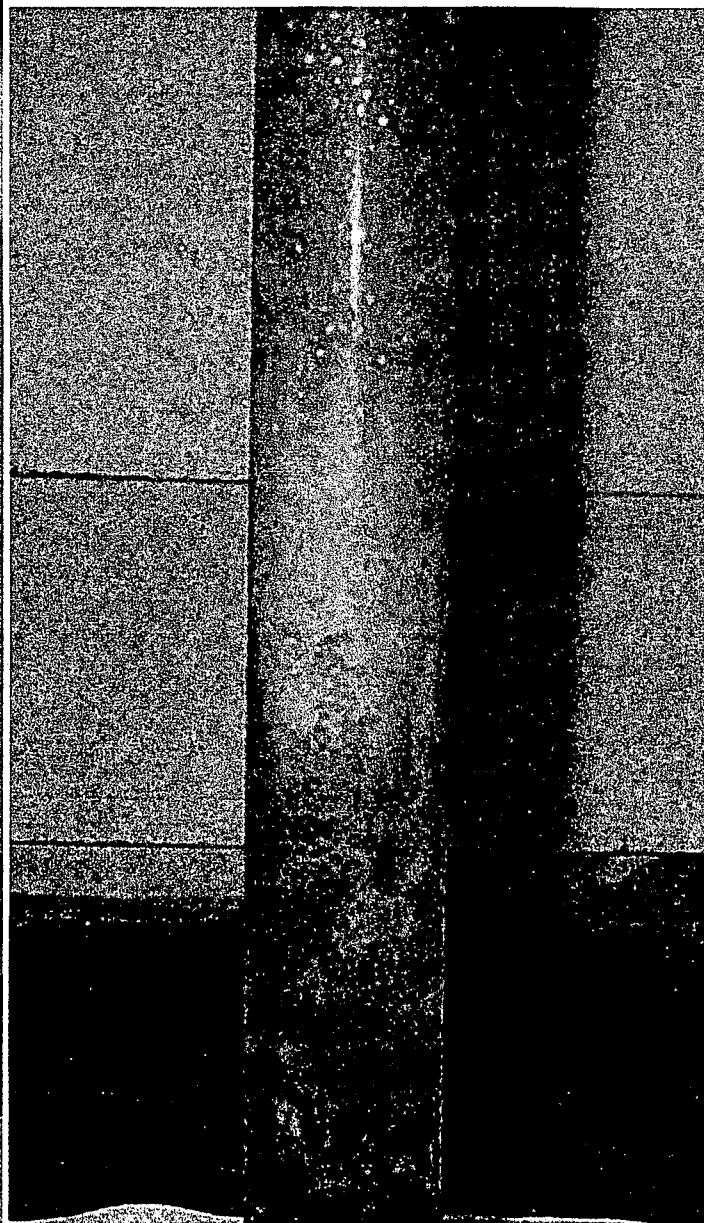
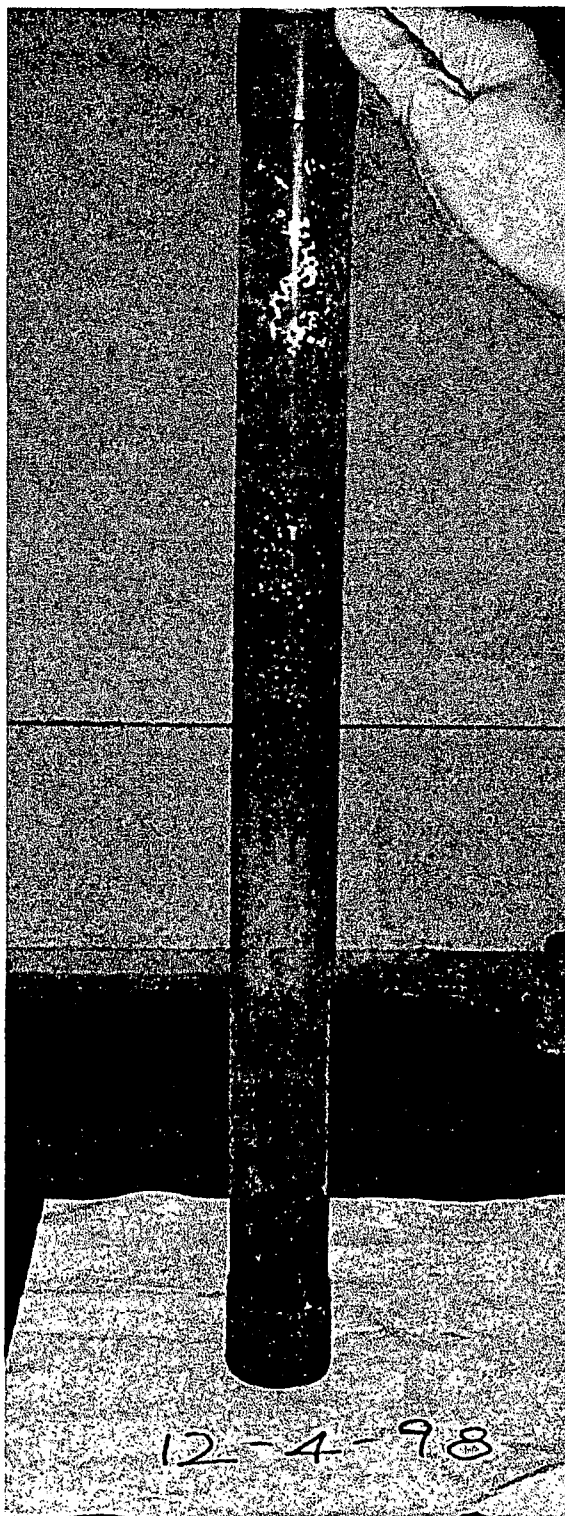
Poly(vinyl chloride) has very low crystallinity but achieves strength and toughness because of the bulky polymer chains (a consequence of the large chlorine substituents). This is apparent in the high T_g of 81°C, although T_g is not so high that processing by a variety of techniques is impaired. Poly(vinyl chloride) is relatively unstable to heat and light with the evolution of hydrogen chloride, which can have deleterious effects on the properties of nearby objects (e.g., electrical components) as well as physiological effects. Metal oxides and fatty acid salts are blended with PVC to stabilize it by slowing down the dehydrohalogenation reaction and reacting with the evolved HCl. PVC is a very tough, rigid material and not as useful in pure

APPENDIX III

Pictures of Soil Core SB-91



Slide #2: Cross section of soil core SB-91 (6'5" to 8'5" BGS).



Slide #1: Soil core SB-91 (6'5" to 8'5" BGS).

Attachment 2

Chem-Ox Pilot Test Summary Report Dated October 1, 1999

CHEM-OX PILOT TEST SUMMARY REPORT

Solutia Inc. Indian Orchard Plant, Springfield, Massachusetts

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October 1, 1999

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1.0 INTRODUCTION

This report summarizes the results of the chemical oxidation (Chem-Ox) pilot test performed at the Former Gas Holder Area of the Solutia Inc. Indian Orchard Plant in Springfield, Massachusetts (Site). The pilot test was designed to determine the feasibility of in-situ oxidation of volatile organic compounds (VOCs), primarily vinyl chloride, that exists in a layer of fine white granular material approximately 5 to 6 feet below surface grade (BSG). The white material layer (presumed to be off-specification standard grade PVC that was buried in 1946) exhibits vinyl chloride concentrations of up to 698 mg/kg with lesser concentrations of trichloroethene (TCE), *cis*-1,2-dichloroethene (DCE), and 1,2-dichloroethane (DCA) detected. It has been suspected that the white material layer is the potential source of vinyl chloride detected in groundwater at the Site.

The Environmental Research Institute (ERI) of Storrs, Connecticut, performed a laboratory treatability study in which sodium permanganate (NaMnO_4) was shown to be effective at oxidizing vinyl chloride in samples collected from the white material layer (Treatability Study for the Application of an In-Situ Oxidation of Vinyl Chloride, Former Gas Holder Area, Solutia Inc., Indian Orchard Plant, Springfield, Massachusetts, ERI, 1999). The laboratory treatability study results were used to determine the required mass of NaMnO_4 solution to oxidize the target volatile organic compounds (VOCs) and to satisfy the natural soil oxidant demand (SOD) within the pilot test area. The purpose of the field pilot test was to determine the following:

- The efficiency of in-situ oxidation of VOCs (primarily vinyl chloride) in the white layer in the test area,
- The distribution and effective radius of influence of sodium permanganate injection into the white layer (for determination of full scale well spacing),
- The injection pressures required, and
- The best technique to deliver the sodium permanganate to the white layer to ensure effective contact.

2.0 PILOT TEST SUMMARY

The Chem-Ox pilot test was performed in July and August of 1999. The testing consisted of pre-pilot test groundwater/soil sampling for baseline conditions, sodium permanganate solution injection over two days, and follow up groundwater/soil sampling. Pilot test chronology is presented in Table 1. In addition, some monitoring wells and sewer drains outside of the test area were sampled to ensure that sodium permanganate solution did not migrate beyond the boundaries of the test area (as discussed with the Massachusetts Department of Environmental Protection (MADEP)). A copy of the letter to Mr. David Slowick of the MADEP regarding the groundwater sampling outside of the test area is presented in Appendix A. Wells selected included MW-58s, MW-87s, MW-92s, MW-93a, and MW-94s and drains D-220, D-222, and D-223.

2.1 PILOT TEST WELL LAYOUT AND WELL/MONITORING POINT CONSTRUCTION

A plan view of the pilot test area is presented in Figure 1. A test area of approximately 20 feet long by 10 feet wide was selected for the pilot study. Construction details of all injection wells and monitoring points are presented in Table 2.

Four pre-pilot test soil samples (SB-111 through SB-114) were taken from the corners of the test area. These samples were used to establish baseline VOC concentrations, to define the geological stratigraphy of the test area, and to collect grain size analysis data to qualitatively estimate the relative permeability of soil layers. Soil samples were collected using an AMS Power Probe 9600 direct push drill rig equipped with a 2 inch nominal AMS Dual Tube Sampler (1-1/2 inch diameter heavy wall plastic liners contain the soil sample within the outer 2 inch sampler).

Two dual level injection well clusters (IW-1s/IW-1d and IW-2s/IW-2d) were installed within the test area at approximately 10 foot on center spacing (i.e., each dual level cluster was designed with an assumed 5 foot radius of influence). The shallow injection wells were designed to inject NaMnO_4 solution above the surface of the white material. The deep injection wells were screened completely within the white layer (between 5 and 6 feet BSG). Injection wells were constructed of 1 inch diameter schedule 40 PVC riser with 6 inch long screened intervals (0.010 inch slot screen). Wells were installed by driving a 2 inch direct push casing equipped with a disposable point to the desired depth and installing the well within the casing. The direct push casing was then withdrawn leaving the disposable point and well in the ground. The soil was then allowed to collapse around the well casing to seal.

Monitoring points (P-1 through P-19) were installed within the white layer at radial distances of 3, 4, and 5 feet from the injection wells oriented in three axial directions at 120 degrees of radial separation. These points were designed to collect water samples from the white layer during the pilot test to determine distribution of the injected solution. Monitoring points were installed using a 1-1/8 inch direct push rod to push an AMS Direct Push Probe Tip (1 inch screened interval) to the desired depth. Once the sample tip was driven to depth, 1/4 inch polyethylene tubing was connected to the sample tip using an AMS Twist-to-Lock connection. Two existing monitoring wells in the area, MW-83s and SB-105, were also used to gauge water table elevations in the test area.

Post-pilot test soil samples (SB-115 through SB-124) were collected using the same method as previously described for the pre-pilot test soil samples. Soil boring sample locations were selected based on groundwater observations from the monitoring points and were placed at between 1 and 5 feet radial distance from the injection wells.

2.2 PRE-PILOT TEST SOIL SAMPLING RESULTS

Four soil samples were collected and analyzed for VOCs by EPA method 8260. Soils were collected in 40 mL VOA vials and methanol preserved. Based on the results of the

analyses, baseline vinyl chloride concentration ranged between 389 and 698 mg/kg. Concentrations of other VOCs (TCE, DCE, DCA) were lower (between 2.4 to 15.3, 71.8 to 90.5, and 2.4 to 25.7, mg/kg, respectively). Note only vinyl chloride was detected above the Massachusetts Contingency Plan (MCP) upper contaminant level (UCL) and therefore vinyl chloride is the only VOC discussed further in this report. Pre-pilot test VOCs concentrations are presented in Table 3. The VOCs concentrations are reported as mg/kg of soil on a dry basis assuming a 30.2% moisture content as determined from a core of white material from soil boring SB-112. Laboratory data is presented in Appendix B.

Soil boring logs from the pre-pilot soil borings are presented in Appendix C. In general the stratigraphy in the test area can be described as approximately 5 to 5.5 feet of brown fine sand and trace fine to medium gravel overlaying approximately 1 foot of fine grained white material. Below the white layer, a medium to coarse sand with fine to medium gravel layer exists. Based on a previous soil boring in the area, it was initially suspected that a relatively low permeability soil lens a few inches thick existed below the white material. However, visual evidence of this soil lens was not seen in any of the pre-pilot (and post-pilot) test soil borings. It was hoped that a low permeability lens below the white material layer would provide a barrier to downward migration of the permanganate solution and would help to ensure efficient contact between the permanganate solution and the white material. However, since the existence of this layer was not confirmed, much care was taken in the placement of the deep injection well screens to ensure that the screens did not penetrate the white layer (i.e., to ensure effective chemical oxidant contact).

Grain size analysis results from pre-pilot soil borings are presented in Appendix D. Qualitatively, analyses indicate that the white material layer is lower in permeability than the soils above and below based on grain size distribution. The grain size analyses were initially intended to confirm the existence of a low permeability lens below the white layer. However as discussed previously, a low permeability lens was not detected upon visual inspection (refer to the boring logs Appendix C) and the grain size analyses do not support the existence of such a layer.

2.3 BASELINE GROUNDWATER QUALITY MEASUREMENTS

On August 3, 1999 prior to the start of NaMnO_4 injection, an initial round of groundwater sampling was conducted within the test area at the injection wells (IW-1 and IW-2), monitoring points (P-1 through P-19), and monitoring wells (MW-83s and SB-105). Water levels were taken using a Solinst water level indicator. Water quality parameters (conductivity, pH, and temperature) were measured using a YSI 6820 Multiparameter Probe with a 610DM Datalogger. Groundwater was collected using a Geopump peristaltic pump.

Groundwater monitoring data is presented in Table 4. Water levels ranged between 5.80 and 5.95 feet BSG within the test area prior to testing. Little or no water could be collected from all of the monitoring points because the groundwater table was at or below the bottom of the monitoring point screens. Water levels were extremely low presumably due to drought conditions experienced at the time. Therefore, baseline groundwater conditions within the test area are based upon monitoring wells MW-83s and SB-105. Baseline groundwater conductivity ranged between 0.31 and 0.54 milliSiemens/centimeter (mS/cm) and pH ranged between 6.04 and 6.21.

Baseline groundwater conductivity ranged between 0.27 and 0.86 mS/cm and pH ranged between 6.20 and 7.11 at monitoring wells outside of the test area.

2.4 CHEM-OX PILOT TEST INJECTION

The Chem-Ox injection phase of the pilot test was conducted from August 4 to 5, 1999 (see Table 1). Permanganate solution was injected at the two deep injection wells (IW-1d and IW-2d) one well at a time in approximately 50 gallon doses. Each well was dosed at approximately 20 grams/liter (g/L) concentration 2 times per day for 2 days during the Chem-Ox injection phase (total of at least 200 gallons solution per well). Initially, the plan was to inject the solution at shallow and deep injection wells in two fifty gallon doses per well (total of 100 gallons of solution in each injection well). However, when the solution was injected into the shallow injection wells (IW-1s and IW-2s) during the first day of the test, the solution immediately short-circuited up the sides of the wells. Since the shallow wells could not deliver the solution to the target depth interval, their use was abandoned. The pilot test was therefore conducted using only the deep injection wells. See Table 1, Pilot Test Chronology for specific details of the Chem-Ox injection process.

Sodium permanganate solution was prepared from 5 gallons of 40% concentrated NaMnO_4 (obtained from Carus Chemical, Inc.) diluted to 200 gallons total volume with potable water from the Site (approximately 20 g/L solution concentration). Two batches were prepared in a 320 gallon polyethylene pick-up mounted tank. The actual diluted batch volume was between 230 and 235 gallons after rinse water from rinsing the 5 gallon concentrated solution containers was returned to the tank. Overall, the total mass of NaMnO_4 injected in the test area was approximately 41 kg over the two day Chem-Ox injection phase. See Table 5 for total volumes of solution injected into each injection well.

A Neptune Series 560 "dia-Pump" $\frac{1}{2}$ Hp metering pump capable of 1.1 gallons per minute (gpm) at 175 psig was used to inject the permanganate solution from the batch tank to the injection wells. Injection flowrate was set at 0.64 gpm which remained constant throughout the test. The volume of solution injected into each well as read from the tank level and the time of injection in each well is reported in Table 1 and Table 5.

As shown in Table 5, the average injection pressures at IW-1d and IW-2d were approximately 10 to 25 psig and 10 to 27 psig, respectively. Injection pressures were high due to the low permeability of the white layer. Injection pressures were lower at IW-1s and IW-2s during the brief injection period likely due to the higher permeability of the soils above the white layer and the short-circuiting of flow around the well casing.

2.5 GROUNDWATER MONITORING DURING THE CHEM-OX INJECTION PHASE

During the Chem-Ox injection phase water levels, conductivity, pH, and permanganate concentrations were measured at all points in the test area (Table 4). Permanganate concentrations were measured, if applicable, by collecting a filtered groundwater sample (Gelman 5 μ m nylon filter) and analyzing with a HACH DR/820 colorimeter for NaMnO₄ concentration.

During injection at the deep injection wells, permanganate solution mounded slightly around the injection well screens (maximum mounding was measured at 2.85 feet BSG, approximately 3.0 feet above the water table as measured in the adjacent shallow injection wells). The mounding was highly localized, as no change in water table elevations was detected at the monitoring wells (MW-83s and SB-105) within the test area.

Since the water table elevation in the test area was at or below the level of the monitoring points nearly all monitoring points produced little or no water for sampling. Only P-13 produced enough water to collect a sample. Conductivity at P-13 increased from 0.75 mS/cm to 2.32 mS/cm over the two day injection period. The pH ranged from 6.55 to 7.05 over the injection period at P-13. No significant changes in conductivity or pH were detected at monitoring wells MW-83s and SB-105 during the injection phase. Sodium permanganate was not detected at any monitoring point or well.

Additionally, no significant changes in conductivity or pH were detected in any of the monitoring wells outside of the test area.

2.6 FOLLOW-UP GROUNDWATER QUALITY MONITORING

Two post-pilot test injection phase groundwater monitoring events were performed on August 12 and August 31, 1999. Data from these monitoring events are presented in Table 4.

Water table elevations increased slightly during follow-up sampling to between 5.45 and 5.79 feet BSG in the test area. Due to the slight increase in water table elevations and permanganate solution injection, many monitoring points that were previously dry yielded water for sampling.

At between 7 and 26 days after permanganate injection, conductivity increased significantly above background levels (from 0.31 to 0.54 mS/cm background up to 1.0 to 11.3 mS/cm) at 10 monitoring points. It is likely that the increases in conductivity are due to the oxidation of VOCs/SOD and the dissociation of permanganate. Each of these processes results in a release of ions into solution (i.e., Cl^- and Na^+) which in turn increases the conductance of the solution. The areas where increases in conductivity were observed are shown on Figure 2. Conductivity changes were observed approximately 4 to 5 feet away from IW-2 in all directions. Conductivity changes were seen up to 4 feet away at IW-1, however, the distribution was not uniform. The change in conductivity observed in monitoring point P-13 over the course of the test is shown on Figure 3. The pH ranged between 6.34 and 7.63 at the monitoring points (no significant change over background levels).

Sodium permanganate was detected at six monitoring points (concentrations were measured between 200 and 1,580 mg/L). The areas where permanganate was detected are also shown on Figure 2. As shown by the figure, the permanganate distribution correlates well with the areas of observed increases in conductivity.

2.7 POST-PILOT TEST SOIL SAMPLING

Ten soil borings were performed to collect soil samples for VOCs analysis to determine efficiency of sodium permanganate distribution and VOCs oxidation efficiency. Soil boring locations (SB-115 through SB-124) were chosen in consideration of permanganate detection and conductivity changes observed at monitoring points.

Sodium permanganate completely saturated the white material layer within 2.5 to 3.0 feet away from IW-2. A brownish discoloration was left behind by the sodium permanganate (manganese dioxide, MnO_2 , an oxidation reaction by-product). Only the top few inches of the white layer was penetrated at 4 feet away. Sodium permanganate/manganese dioxide was detected in soils above the white layer, which apparently migrated from the injection well when the permanganate solution was mounding during the injection phase. It appears that in areas where permanganate partially penetrated the white layer, permanganate likely percolated in from the sandy soils above. Beyond 5 feet away from IW-2, sodium permanganate and/or manganese dioxide precipitate was not observed in or above the white layer. The extent and degree of sodium permanganate solution penetration around the injection well is depicted on Figure 4.

Around injection well IW-1, permanganate only fully saturated the white layer 1 to 1.5 feet away. Limited partial penetration was observed at up to 4 feet away. See Figure 4 for the approximate extent of permanganate distribution around IW-1.

See Table 6 for results of post-pilot test VOCs analyses. Soil samples were typically collected from the part of the white layer that exhibited permanganate penetration, if observed. Vinyl chloride concentrations decreased to below 20 mg/kg throughout the

portion of the white layer where sodium permanganate penetration was observed in SB-115, SB-117, SB-118, SB-120, SB-123 and SB-124. In SB-121 only one inch of permanganate penetration was observed, but vinyl chloride levels decreased to 21 mg/kg in this interval. Below the permanganate penetrated interval in SB-121, concentrations of vinyl chloride remain elevated at 189 mg/kg. In SB-122 only one half inch penetration was observed, but the vinyl chloride concentration in the white layer appears to have decreased to 64 mg/kg. SB-116 showed no indications of permanganate, and the concentration of vinyl chloride remained at background levels. However, at SB-119 in the middle of the test area, concentrations appear to have decreased significantly to 35 mg/kg but no permanganate was observed.

In general, soil vinyl chloride concentrations decreased to below the MCP UCL of 20 mg/kg where permanganate penetration was observed directly. It also appears that concentrations have declined significantly (40% or more) throughout the entire test area compared to background even in areas where permanganate penetration was not visually observed.

3.0 CONCLUSIONS

Based on the results of the pilot test the following conclusions can be made:

- Sodium permanganate injection at IW-2 reduced vinyl chloride concentrations throughout the entire thickness (approximately 12 inches) of the white material layer within 3 feet of the injection points to below the MCP UCL of 20 mg/kg. Similarly at IW-1, concentrations were reduced below 20 mg/kg within 1 to 2 feet of the injection points throughout the entire thickness of the white layer.
- Beyond 1 to 3 feet from the injection wells, vinyl chloride concentrations were significantly reduced in the top several inches of the white layer where NaMnO_4 had penetrated (in most cases concentrations were reduced to below 20 mg/kg).
- In general, soil vinyl chloride concentrations declined significantly (40% or more) throughout the entire test area compared to background even in areas where permanganate penetration was not visually observed.
- Required injection pressures were high (up to 27 psig) to induce the solution flowrate of 0.6 gpm into the white material.
- Distribution of permanganate solution was not as efficient as expected due to the low permeability of the white material layer. Permanganate completely saturated the white material within 1 to 3 feet of the injection points. However, only the top several inches of white material was saturated with NaMnO_4 out to approximately 4 feet from the injection points. No NaMnO_4 was detected beyond 5 feet from the injection points.
- No groundwater impacts due to permanganate injection were detected at any of the monitoring wells outside of the test area.

Based on the pilot test results, in-situ chemical oxidation using NaMnO_4 will be highly effective in remediating the white material containing vinyl chloride to below the MCP UCL. The efficiency, however, could be limited by the low permeability of the white material layer that limits the ability to inject the permanganate solution. A dense injection well spacing will therefore be necessary to effectively distribute the NaMnO_4 solution through the entire white material layer.

4.0 RECOMMENDATIONS

- Implement sodium permanganate injection using injection wells at a 6-foot on center well spacing. The recommended well spacing is based on the radius of influence observed during the pilot test that indicated complete saturation of the white material within 3 feet of IW-2 and at least partial saturation of the white material within 3 feet of IW-1. It should be noted that even in areas of partial saturation significant reduction (40% or more) in soil vinyl chloride concentration was observed. The high density of injection wells resulting from using a 6-foot on center spacing should allow for overlapping treatment throughout most of the area targeted for remediation.
- Confirmatory soil sampling should be performed to ensure that the MCP UCL for vinyl chloride has been met throughout the entire treatment area. If there are areas where the soil vinyl chloride concentration remains elevated above the MCP UCL, additional injections of permanganate solutions into these areas can be performed.
- Inject the permanganate solution using single level injection wells screened discretely in the white material layer (instead of the dual level injection wells originally conceptualized). Using single level injection wells will reduce the number of injection wells by half, which will offset the increase in number of wells due to tighter well spacing.
- A direct sensing soil conductivity probe should be used during injection well installation to map the soil lithology and determine the exact elevation and thickness of the white material. This information could then be used to ensure that the screened interval of the injection wells is installed completely within the white material, which will aid in distribution of the permanganate solution.
- Permanganate solution should be injected at a slightly slower flow rate to reduce the injection pressure. This will allow more of the permanganate to flow into the white material and reduce the likelihood that permanganate will flow over the top of the white material layer.
- A dosing schedule similar to the pilot test (20 g/L solution injected in 50 gallon doses at each injection point) should be implemented to ensure effective contact.

5.0 FULL-SCALE COST ESTIMATE

Based on the results of the pilot test, the original full-scale cost estimate will be revised. A full-scale proposal and cost estimate will be submitted to Blasland, Bouck, and Lee, Inc. under a separate cover.

TABLES

TABLE 1
PILOT TEST CHRONOLOGY
CHEM-OX PILOT TEST - SOLUTIA INDIAN ORCHARD FACILITY, SPRINGFIELD, MA
XDD Project No. 39051

Date	Event	Notes
July 13, 1999	Install Pre-Pilot soil borings and collect samples of white material for laboratory analysis	Collect soil samples at soil borings SB-111 through SB-114.
August 3, 1999	Perform background groundwater sampling in test area	Monitoring points (P-1 through P-19) and injection wells (IW-1s, IW-1d, IW-2s, and IW-2d) were dry - water levels measured in monitoring wells MW-83s and SB105 were approximately 5.80 to 5.95 feet BSG, respectively (i.e., at or below the screened intervals of the test points)
August 4, 1999	Inject 235 gallons of NaMnO ₄ solution at injection wells. Begin sampling water at monitoring points (P-1 through P-19).	10:15 AM - Started simultaneous injection at IW-1d and IW-2d @ 10:15. Approximately 10 gallons permanganate injected into IW-2d 10:30 AM - Reconfigured manifold to inject at IW-1d only because injection pressure differences at the wells caused most of the permanganate to flow into IW-2d only. Each well was dosed separately from this point on. 50 gallons permanganate solution injected into IW-1d. 11:50 AM - Switched manifold to IW-2d. Injected 55 gallons permanganate into IW-2d. 1:20 PM - Switched manifold to IW-1s. 1:30 PM - Halt permanganate injection at IW-1s because solution flow short-circuited up the sides of the injection well and began to fill the roadbox with permanganate. Ten (10) gallons injected into IW-1s 1:35 PM - Restart injection at IW-2s. Permanganate solution short-circuited at the injection well and began to fill the roadbox. Injection was halted before less than 5 gallons was injected. 1:45 PM - Based on shallow injection well performance it was decided to inject all permanganate at deep injection wells in 50 gallon doses. Restart injection at IW-1d. Approximately 65 gallons permanganate injected at IW-1d 3:10 PM - Switch manifold to IW-2d. Inject 45 gallons of permanganate solution 4:25 PM - Injection halted for day. Total volume solution injected 235 gallons
August 5, 1999	Inject 230 gallons of NaMnO ₄ solution at injection wells. Perform groundwater sampling monitoring points (P-1 through P-19), injection wells, and monitoring wells	10:45 AM - Start injection of permanganate solution at IW-1d (inject 60 gallons) 12:15 PM - Switched manifold to IW-2d (inject 45 gallons) 1:45 PM - Switched manifold to IW-1d (inject 65 gallons) 3:15 PM - Switched manifold to IW-2d (inject 60 gallons) 4:50 PM - Dosing completed. Total volume solution injected 230 gallons
August 12, 1999	Perform round of groundwater sampling at monitoring points, injection wells, and monitoring wells	Water detected/sampled at almost all monitoring points. Groundwater table detected at 5.61 and 5.79 feet BSG at MW-83s and SB105, respectively in test area. Permanganate solution detected at P-8 and P-13.
August 31, 1999	Perform final round of groundwater sampling. Begin collecting Post-Pilot soil samples	Collect samples at soil borings SB-115 through SB-117 (3 soil borings)
September 1, 1999	Collect Post-Pilot soil samples and soil cores in test area	Collect samples at soil borings SB-118 through SB-124 (7 soil borings). Collect soil core for capillary pressure/saturation curve analysis at SB-125 (installed adjacent to MW-83s).

TABLE 2
PILOT TEST TEST POINT/INJECTION WELL CONSTRUCTION DATA
CHEM-OX PILOT TEST - SOLUTIA INDIAN ORCHARD FACILITY, SPRINGFIELD, MA
XDD Project No. 39051

Point ID	Bottom of Screen	Top of Screen	Notes	
	(feet BSG)	(feet BSG)		
MW-83S	17.8	nm	Monitoring Well	
SB-105	7.7	nm	Monitoring Well	
SB-111	n/a	n/a	Pre-Pilot soil boring locations (SB-111 through SB-114)	
SB-112	n/a	n/a		
SB-113	n/a	n/a		
SB-114	n/a	n/a		
SB-115	n/a	n/a	Post-Pilot soil boring locations (SB-115 through SB-124)	
			Radial Distances:	1.0' - IW-2d
SB-116	n/a	n/a	[radius in feet from injection well(s)]	5.0' - IW-2d
SB-117	n/a	n/a		2.5' - IW-2d
SB-118	n/a	n/a		3.0' - IW-2d
SB-119	n/a	n/a		5.0' - IW-1d/IW-2d
SB-120	n/a	n/a		4.0' - IW-1d
SB-121	n/a	n/a		2.0' - IW-1d
SB-122	n/a	n/a		3.0' - IW-1d
SB-123	n/a	n/a		1.0' - IW-1d
SB-124	n/a	n/a		4.0' - IW-2d
IW-1s	5' 9"	5' 3"	Injection Wells - 1 inch I.D. PVC, 10 slot screen, direct push (IW-1s, IW-1d, IW-2s, IW-2d)	
IW-1d	6' 2"	5' 8"		
IW-2s	5' 1"	4' 7"		
IW-2d	5' 7"	5' 1"		
P-1	6' 3"	6' 2"	All monitoring Points (P-1 through P-19) - AMS 1-1/8" GVP Tip x 1/4" polyethylene tubing	
P-2	6' 3"	6' 2"		
P-3	6' 3"	6' 2"		
P-4	6' 6"	6' 5"		
P-5	6' 6"	6' 5"		
P-6	6' 6"	6' 5"		
P-7	6' 0"	5' 11"		
P-8	6' 0"	5' 11"		
P-9	6' 0"	5' 11"		
P-10	6' 0"	5' 11"		
P-11a	—	—		
P-11b	6' 0"	5' 11"	Lost point, install P-11b	
P-12	6' 0"	5' 11"		
P-13a	—	—	Point did not stay in ground, install P-13b	
P-13b	5' 9"	5' 8"		
P-14	5' 9"	5' 8"		
P-15	5' 9"	5' 8"		
P-16	5' 6"	5' 5"		
P-17	5' 6"	5' 5"		
P-18	4' 6"	4' 5"	Drill rod bent on rock	
P-19	5' 6"	5' 5"	Point pulled out while installing	

Table 3
Pre- Pilot Test Soil VOCs Concentrations mg/kg*
CHEM-OX PILOT TEST - Solutia INDIAN ORCHARD FACILITY, SPRINGFIELD, MA
XDD Project No. 39051

Sample ID/Sample Depth	Vinyl chloride	<i>cis</i> -1,2-Dichloroethene	1,2-Dicholoroethane	Trichloroethene
SB 111 5'11"-6'6"	698.0	90.5	3.0	3.0
SB 112 5'6"-6'10"	389.1	83.4	25.7	3.9
SB 113 5'7"-6'0"	526.4	71.8	2.8	15.3
SB 114 4'11"-6'0"	429.0	88.7	2.4	2.4
Blank**	< 1.0	< 1.0	< 1.0	< 1.0

* dry basis based on estimated 30% moisture content

** results are expressed in mg/L.

TABLE 4
PILOT TEST GROUNDWATER MONITORING DATA
CHEM-OX PILOT TEST - SOLUTIA INDIAN ORCHARD FACILITY, SPRINGFIELD, MA
XDD Project No. 39051

Point ID	Date	Time	pH	Conductivity	Temp	NaMnO ₄ Concentration	DTW	Notes
				(mS/cm)	(°F)	(mg/L)	(feet BSG)	
IW-1s	08/03/99	--	--	--	--	--	dry	
	08/04/99	10:45	6.30	22.78	28.20	color	3.60	
	08/04/99	11:15	--	--	--	--	3.10	
	08/04/99	11:50	--	--	--	--	2.85	
	08/04/99	12:10	--	--	--	--	5.35	water level dropping
	08/04/99	13:10	--	--	--	--	5.50	
	08/05/99	9:50	--	--	--	--	dry	
	08/05/99	11:50	--	--	--	--	2.85	
	08/12/99	12:30	--	--	--	12,850	5.79	not enough liquid to sample parameters - composite sample from IW-1s and IW-1d
	08/31/99	--	7.36	4.33	27.37	53	5.56	only small amount of liquid at bottom - composite sample from IW-1s and IW-1d
IW-1d	08/03/99	--	--	--	--	--	6.00	
	08/05/99	9:50	--	--	--	color	--	
	08/12/99	12:30	--	--	--	see IW-1s	5.85	only small amount of liquid at bottom - composite sample from IW-1s and IW-1d
	08/31/99	--	--	--	--	see IW-1s	5.61	only small amount of liquid at bottom - composite sample from IW-1s and IW-1d
IW-2s	08/03/99	--	--	--	--	--	dry	
	08/04/99	12:10	6.74	31.06	11.64	color	3.80	
	08/04/99	12:50	--	--	--	--	3.50	
	08/04/99	13:10	--	--	--	--	3.42	
	08/04/99	15:35	--	--	--	--	3.80	
	08/05/99	9:50	--	--	--	--	dry	
	08/05/99	11:50	--	--	--	--	dry	
	08/12/99	12:30	--	--	--	--	dry	dry - no sample
	08/31/99	--	--	--	--	--	dry	
IW-2d	08/03/99	--	--	--	--	--	dry	
	08/04/99	9:50	--	--	--	--	5.50	
	08/12/99	12:30	--	--	--	--	dry	dry - no sample
	08/31/99	--	8.23	3.33	28.16	1.2	5.26	Sample was yellowish in color after filtration - not violet in color - may not be permanganate
SB105	08/03/99	--	--	--	--	--	5.95	
	08/04/99	11:07	6.21	0.38	25.08	nd	6.00	
	08/04/99	11:50	--	--	--	--	6.00	
	08/05/99	9:50	6.21	0.31	24.80	nd	6.00	
	08/12/99	12:15	7.43	0.27	27.81	nd	5.79	
	08/31/99	--	7.02	0.44	25.43	nd	5.57	
MW83s	08/03/99	--	--	--	--	--	5.80	
	08/05/99	9:50	6.04	0.54	22.33	nd	5.85	
	08/12/99	12:20	7.12	0.56	22.21	nd	5.61	
	08/31/99	--	6.45	0.57	23.62	nd	5.45	
P-1	08/03/99	--	--	--	--	--	na	dry
	08/04/99	11:00	--	--	--	--	na	dry
	08/04/99	11:35	--	--	--	--	na	dry

TABLE 4
PILOT TEST GROUNDWATER MONITORING DATA
CHEM-OX PILOT TEST - SOLUTIA INDIAN ORCHARD FACILITY, SPRINGFIELD, MA
XDD Project No. 39051

Point ID	Date	Time	pH	Conductivity	Temp	NaMnO ₄ Concentration	DTW	Notes
				(mS/cm)	(°F)	(mg/L)	(feet BSG)	
	08/05/99	10:30	--	--	--	--	na	dry
	08/05/99	15:35	--	--	--	nd	na	droplets
	08/12/99	10:45	--	--	--	--	na	dry
	08/31/99	--	--	--	--	--	na	dry
P-2	08/03/99	--	--	--	--	--	na	dry
	08/05/99	15:35	--	--	--	nd	na	droplets
	08/12/99	10:30	6.82	0.40	29.95	nd	na	
	08/31/99	--	6.39	0.71	22.43	nd	na	brown, silty water - clear after filtration
P-3	08/03/99	--	--	--	--	--	na	dry
	08/05/99	15:35	--	--	--	nd	na	droplets, silty
	08/12/99	10:20	7.05	0.36	28.74	nd	na	
	08/31/99	--	6.47	0.25	22.31	nd	na	
P-4	08/03/99	--	--	--	--	--	na	dry
	08/04/99	11:35	--	--	--	nd	na	drops
	08/05/99	10:30	--	--	--	nd	na	droplets
	08/05/99	15:35	--	--	--	nd	na	droplets
	08/12/99	10:40	6.48	1.15	31.70	nd	na	composite sample with P-5 and P-6 - not enough water to sample individual points
	08/31/99	--	6.34	0.60	24.74	nd	na	composite sample with P-5 and P-6
P-5	08/03/99	--	--	--	--	--	na	dry
	08/05/99	15:35	--	--	--	nd	na	droplets
	08/12/99	10:40	see P-4 data				na	composite sample with P-4 and P-6 - not enough water to sample individual points
	08/31/99	--	see P-4 data				na	composite sample with P-4 and P-6
P-6	08/03/99	--	--	--	--	--	na	dry
	08/05/99	15:35	--	--	--	--	na	droplets
	08/12/99	10:40	see P-4 data				na	composite sample with P-4 and P-5 - not enough water to sample individual points
	08/31/99	--	see P-4 data				na	composite sample with P-4 and P-5
P-7	08/03/99	--	--	--	--	--	na	dry
	08/04/99	11:00	--	--	--	--	na	dry
	08/04/99	11:35	--	--	--	--	na	drops - under pressure
	08/05/99	10:30	--	--	--	1,000	na	droplets
	08/12/99	10:45	--	--	--	--	na	droplets - not enough to sample. Appeared that NaMnO ₄ was present but color changed to yellow after filtration.
	08/31/99	--	6.84	1.00	23.43	nd	na	
P-8	08/03/99	--	--	--	--	--	na	dry
	08/04/99	11:00	--	--	--	--	na	dry
	08/05/99	10:30	--	--	--	1,200	na	droplets
	08/12/99	10:50	--	--	--	color	na	droplets - NaMnO ₄ detected but not enough to sample
	08/31/99	--	7.63	0.03	24.96	nd	na	
P-9	08/03/99	--	--	--	--	--	na	dry
	08/05/99	15:35	--	--	--	--	na	dry
	08/12/99	11:00	--	--	--	nd	na	droplets - not enough to sample
	08/31/99	--	--	--	--	--	na	dry
P-10	08/03/99	--	--	--	--	nd	na	dry

TABLE 4
PILOT TEST GROUNDWATER MONITORING DATA
CHEM-OX PILOT TEST - SOLUTIA INDIAN ORCHARD FACILITY, SPRINGFIELD, MA
XDD Project No. 39051

Point ID	Date	Time	pH	Conductivity	Temp	NaMnO ₄ Concentration	DTW	Notes
				(mS/cm)	(°F)	(mg/L)	(feet BSG)	
	08/05/99	15:55	--	--	--	nd	na	droplets, silty
	08/12/99	11:10	6.70	1.23	32.01	nd	na	
	08/31/99	--	7.05	0.11	25.91	nd	na	
P-11	08/03/99	--	--	--	--	--	na	dry
	08/05/99	15:55	--	--	--	nd	na	droplets, silty
	08/12/99	11:15	6.72	2.33	30.73	nd	na	
	08/31/99	--	--	--	--	nd	na	droplets - not enough water to sample
P-12	08/03/99	--	--	--	--	--	na	dry
	08/05/99	9:50	--	--	--	--	na	dry
	08/05/99	15:55	--	--	--	nd	na	droplets
	08/12/99	11:20	6.94	3.58	31.68	340	na	NaMnO ₄ detected
	08/31/99	--	6.73	1.16	25.10	nd	na	a lot of water yielded from this point
P-13	08/03/99	--	--	--	--	--	na	dry
	08/05/99	9:50	6.55	0.75	28.10	nd	na	droplets
	08/05/99	16:15	7.05	2.32	32.00	nd	na	droplets
	08/12/99	11:30	7.33	11.33	30.84	1,580	na	NaMnO ₄ detected
	08/31/99	--	7.50	10.08	24.99	7	na	a lot of water yielded - silty
	08/31/99	--	7.34	8.97	25.77	180	na	NaMnO ₄ appeared during sampling, a second sample was analyzed using water collected after pumping > 5 minutes
P-14	08/03/99	--	--	--	--	--	na	dry
	08/05/99	16:15	--	--	--	nd	na	droplets
	08/12/99	11:40	--	--	--	nd	na	droplets - not enough to sample - under pressure, clear water with strong sulfur odor
	08/31/99	--	7.06	2.57	26.55	nd	na	
P-15	08/03/99	--	--	--	--	--	na	dry
	08/05/99	16:15	--	--	--	nd	na	droplets, silty
	08/12/99	11:50	7.28	1.08	31.95	nd	na	
	08/31/99	--	6.72	0.43	26.17	nd	na	
P-16	08/03/99	--	--	--	--	--	na	dry
	08/04/99	12:30	--	--	--	nd	na	drops - under pressure
	08/05/99	9:50	--	--	--	nd	na	dry
	08/05/99	16:20	--	--	--	200	na	droplets, silty
	08/12/99	12:00	7.25	1.73	31.42	nd	na	
	08/31/99	--	6.83	3.64	26.56	nd	na	
P-17	08/03/99	--	--	--	--	--	na	dry
	08/04/99	12:30	--	--	--	--	na	dry
	08/05/99	16:20	--	--	--	color	na	droplets
	08/12/99	12:05	7.27	1.17	33.02	nd	na	
	08/31/99	--	7.36	1.47	27.44	nd	na	
P-18	08/03/99	--	--	--	--	--	na	dry
	08/04/99	12:30	--	--	--	--	na	dry
	08/05/99	9:50	--	--	--	--	na	dry
	08/05/99	16:20	--	--	--	--	na	dry
	08/12/99	12:10	--	--	--	--	na	dry

TABLE 4
PILOT TEST GROUNDWATER MONITORING DATA
CHEM-OX PILOT TEST - SOLUTIA INDIAN ORCHARD FACILITY, SPRINGFIELD, MA
XDD Project No. 39051

Point ID	Date	Time	pH	Conductivity	Temp	NaMnO ₄ Concentration	DTW	Notes
				(mS/cm)	(°F)	(mg/L)	(feet BSG)	
	08/31/99	--	--	--	--	--	na	dry
P-19	08/03/99	--	--	--	--	--	na	dry
	08/05/99	16:20	--	--	--	nd	na	droplets, silty
	08/12/99	12:10	--	--	--	nd	na	droplets
	08/31/99	--	7.42	0.70	28.18	nd	na	
MW93a	08/05/99	13:10	7.11	0.86	21.36	nd	5.35	
	08/12/99	13:30	7.03	0.50	21.53	nd	5.36	
	08/31/99	--	7.08	0.81	21.81	nd	nm	could not measure water table, well blocked with tubing
MW92s	08/05/99	15:05	6.40	0.27	23.61	nd	5.02	
	08/12/99	13:35	7.31	0.31	22.52	nd	4.86	
	08/31/99	--	6.77	0.40	23.63	nd	4.71	
MW58s	08/05/99	--	--	--	--	--	--	locked not accessible
MW94s	08/05/99	13:25	7.02	0.86	22.52	nd	5.25	
	08/12/99	13:25	6.83	0.64	25.01	nd	4.46	
	08/31/99	--	7.24	0.57	23.19	nd	4.78	
MW87s	08/05/99	13:30	6.20	0.47	22.50	nd	5.05	
	08/12/99	13:20	6.70	0.02	23.47	nd	4.85	strong odor at well
	08/31/99	--	6.89	0.46	23.17	nd	4.70	
D220	08/05/99	12:30	7.67	0.39	27.62	nd	na	
	08/12/99	12:30	7.41	0.38	29.89	nd	na	
	08/31/99	--	6.99	0.05	25.17	nd	na	
D222	08/05/99	13:40	--	--	--	--	na	Fire Sprinkler system activated prior to sampling - not representative not sampled
	08/12/99	13:10	6.78	0.16	26.37	nd	na	
D223	08/05/99	13:40	--	--	--	--	na	Fire Sprinkler system activated prior to sampling - not representative not sampled
	08/12/99	13:15	7.23	0.04	31.73	nd	na	

Notes:

DTW = depth to water

na = not applicable

nd = not detected

nm = not measured

-- = no data

color = NaMnO₄ detected visually but not enough sample collected to analyze for concentration.

Table 5
PILOT TEST PERMANGANATE INJECTION DATA
CHEM-OX PILOT TEST - SOLUTIA INDIAN ORCHARD FACILITY, SPRINGFIELD, MA
XDD Project No. 39051

Injection Well ID	Day 1 (8/4/99)		Day 2 (8/5/99)		Total Volume
	Volume	Pressure Range, PSI	Volume	Pressure Range, PSI	
IW 1D	110	10 to 25	125	10 to 17	235
IW 1S	10 [1]	n/m	[1]	n/m	10
IW 2D	115	17 to 27	105	10 to 25	220
IW 2S	~0	n/m	~0	n/m	<5
Notes:					
n/m = not measured					
[1] Injection halted due to short circuiting flow around well casing					

Table 6
Post-Pilot Test Soil VOC Concentrations (mg/kg^a)
CHEM-OX PILOT TEST - SOLUTIA INDIAN ORCHARD FACILITY, SPRINGFIELD, MA
XDD Project No. 39051

Sample ID/Sample Depth	Vinyl chloride	<i>cis</i> -1,2-Dichloro ethene	1,2-Dichloro ethane	Trichloro ethene	NaMnO ₄ Detected (Y/N)	Radial Distance from Injection Well (feet)	White Layer Thickness (inches) ^c	NaMnO ₄ Impacted Thickness (inches) ^d
SB115 5'5"-5'10"	<0.28	<0.17	<0.17	<0.17	Y	1.0	5.0	5.0
SB116 5'3"-6'0"	260.33	29.12	<0.18	<0.18	N	5.0	9.0	0.0
SB117 5'4"-6'0"	<0.18	<0.18	2.65	<0.18	Y	2.5	8.0	8.0
SB118 5'2"-5'9"	<0.15	<0.15	6.88	<0.85	Y	3.0	10.0	7.0
SB119 5'4.5"-5'11"	35.15	13.14	5.72	3.21	N	5.0	6.5	0.0
SB120 5'4.5"-5'7"	<0.14	0.14	5.95	1.65	Y	4.0	7.5	2.5
SB121 5'6.5"-5'7.5"	21.14	5.54	3.56	3.20	Y	2.0	5.5	1.0
SB121 5'7.5"-6'0"	189.20	0.19	3.31	<0.87	N	2.0	5.5	0.0
SB122 5'5.5"-6'0"	63.56	9.10	6.01	<0.18	Y	3.0	6.5	0.5
SB123 5'7.5"-6'0"	<0.14	<0.14	2.57	<0.80	Y	1.0	4.5	4.5
SB124 5'0.5"-5'3"	10.27	4.17	1.07	4.09	Y	4.0	6.0	2.5
Blank ^b	< 1	< 1	< 1	< 1				

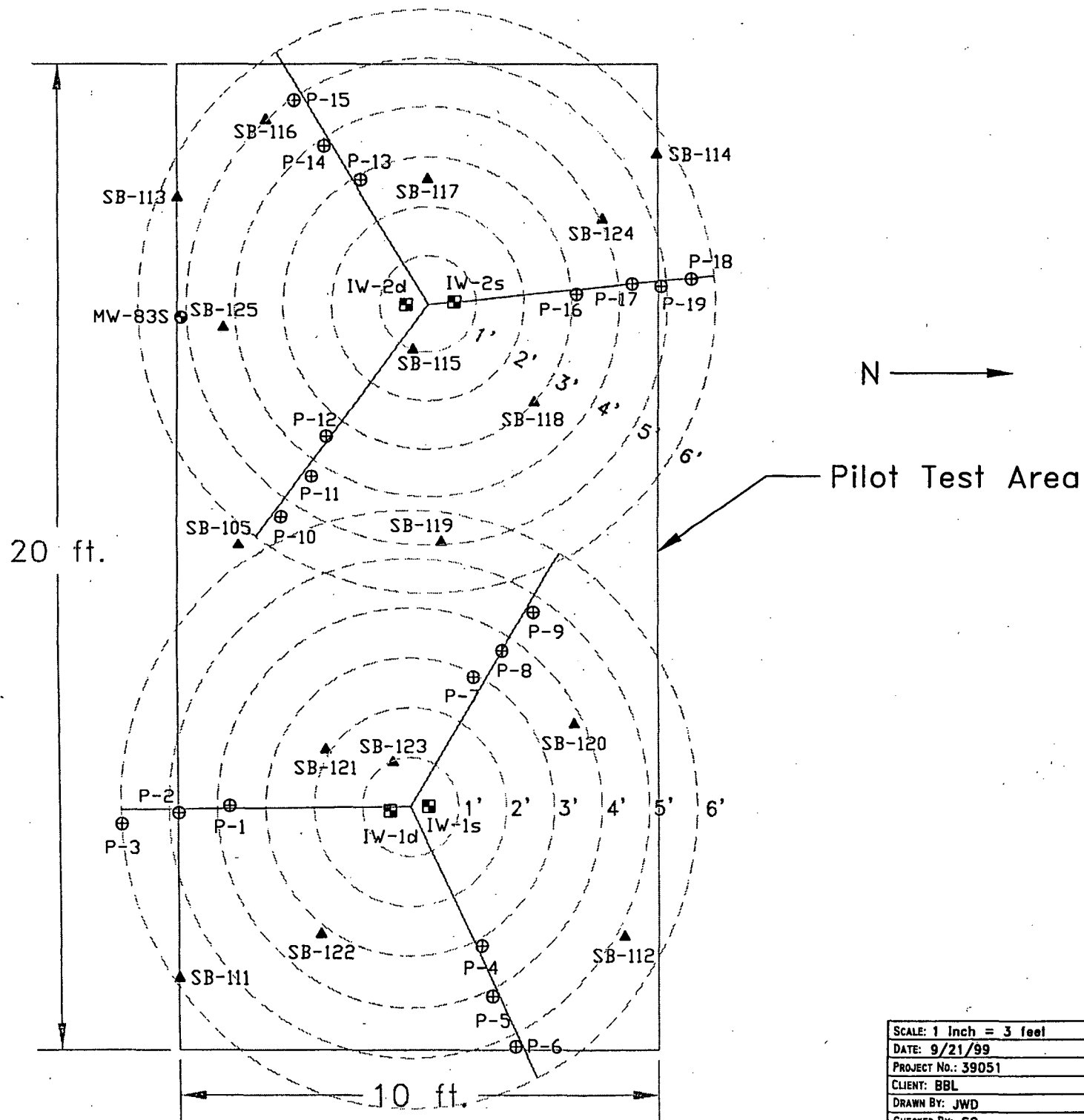
^a dry basis based on estimated 30% moisture content in white material layer (from soil core SB-112)

^b results are expressed in mg/L.

^c thickness of white layer observed in the sample

^d thickness of the white material that exhibited NaMnO₄ penetration and/or manganese dioxide precipitate discoloration visually

FIGURES



Scale

1 inch



3 feet



**XPERT
DESIGN
AND
DIAGNOSTICS, LLC.**

SCALE: 1 inch = 3 feet

DATE: 9/21/99

PROJECT NO.: 39051

CLIENT: BBL

DRAWN BY: JWD

CHECKED BY: SC

PROJ. MGMT. APPROVAL: SC

TITLE:

Pilot Test Area

DRAWING NO.

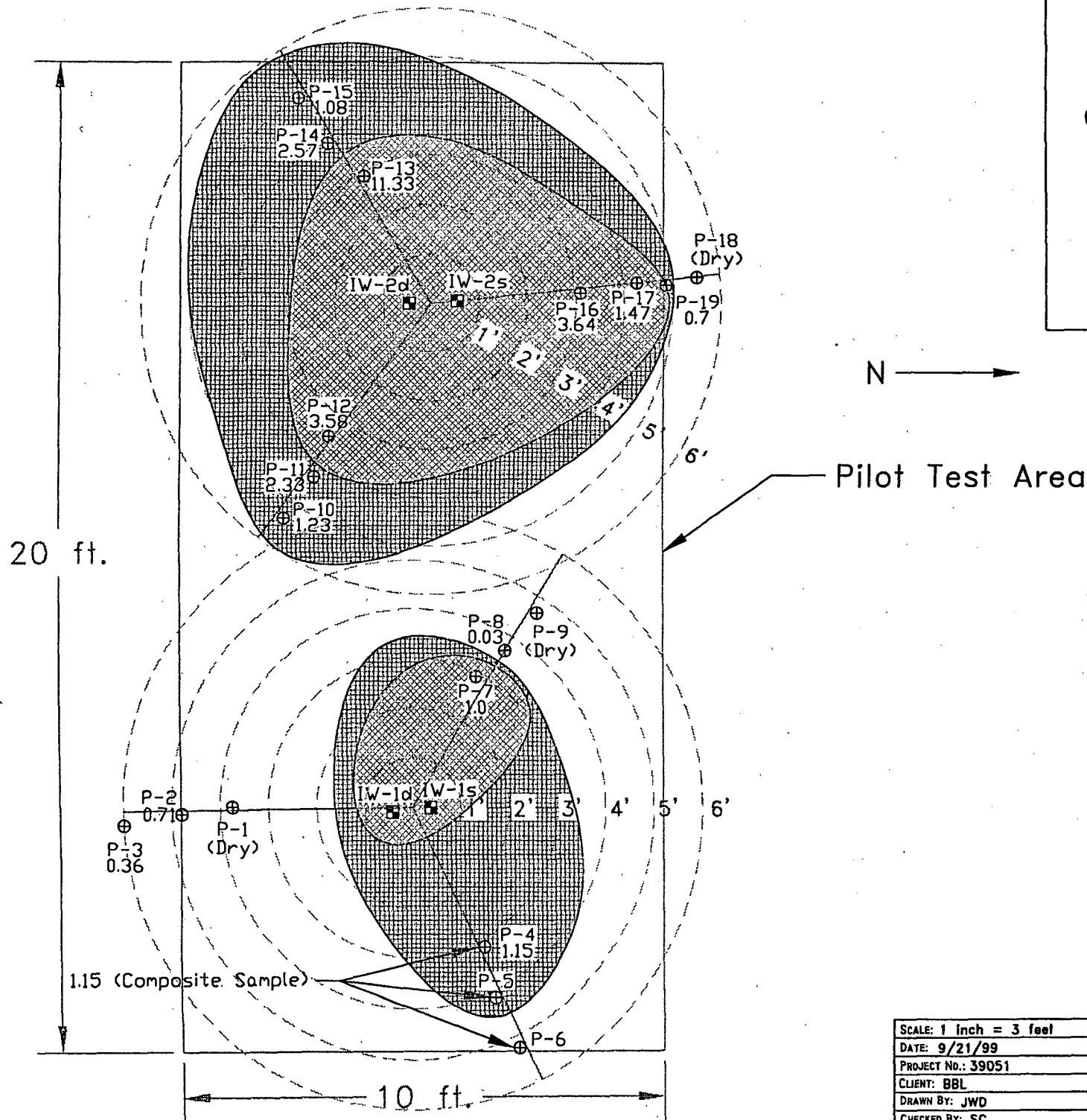
Figure 1

REV.

B

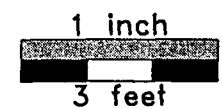
Legend

- ▲
P-XX
Conductivity (mS/cm)
(milliSiemens/centimeter)
- Estimated Areas
Conductivity
Above Background
(0.31 to 0.54)
- NaMnO₄
Detected



Note: Maximum conductivity value recorded during pilot test.

Scale



XPERT
DESIGN
AND
DIAGNOSTICS, LLC.

SCALE: 1 inch = 3 feet
DATE: 9/21/99
PROJECT No.: 39051
CLIENT: BBL
DRAWN BY: JWD
CHECKED BY: SC
PROJ. MGMT. APPROVAL: SC

TITLE:
Groundwater
Monitoring Data

DRAWING NO. Figure 2 REV. B

Figure 3
Groundwater Conductivity at P-13 After NaMnO₄ Injection
CHEM-OX PILOT TEST - SOLUTIA INDIAN ORCHARD FACILITY, SPRINGFIELD, MA
XDD Project No. 39051

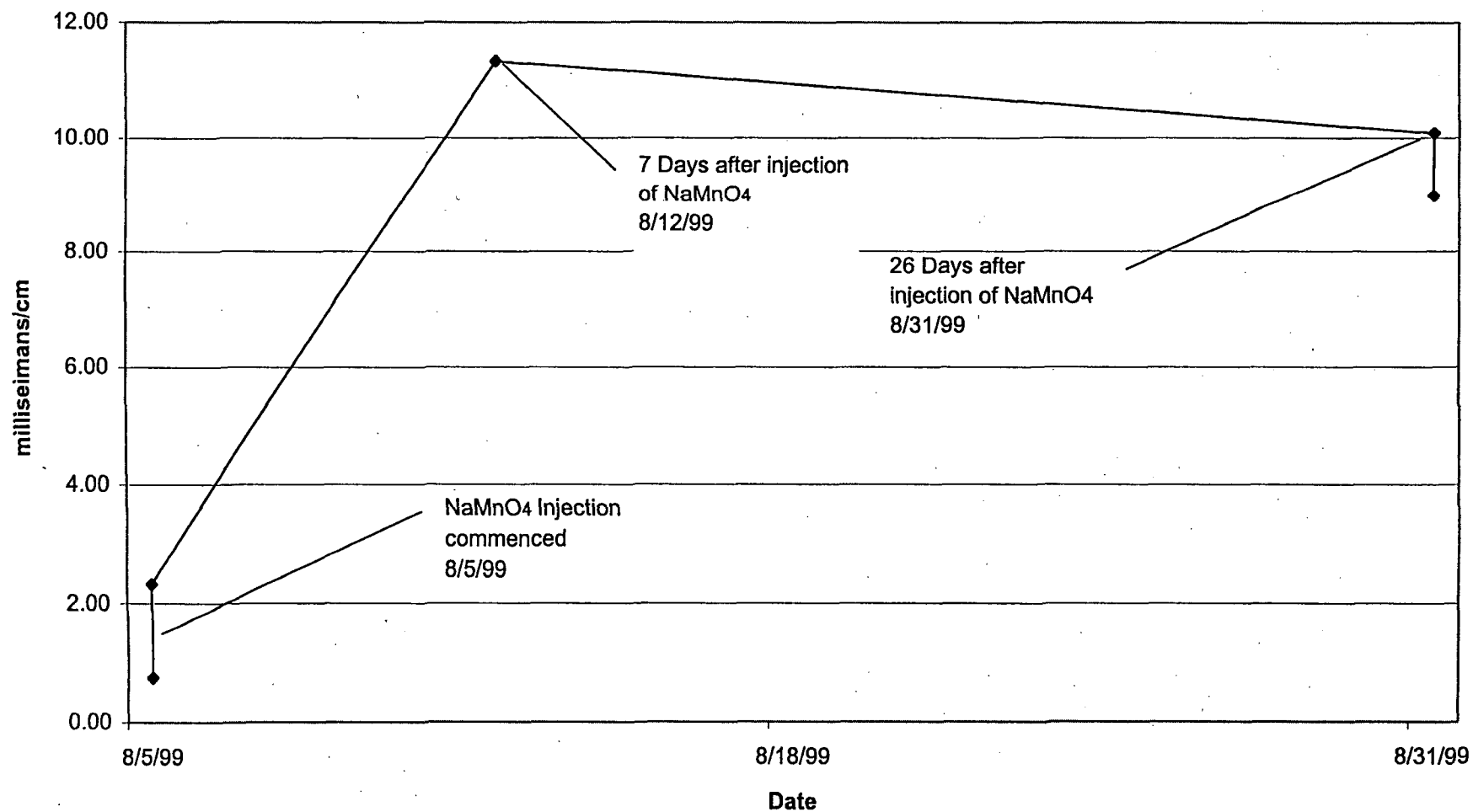
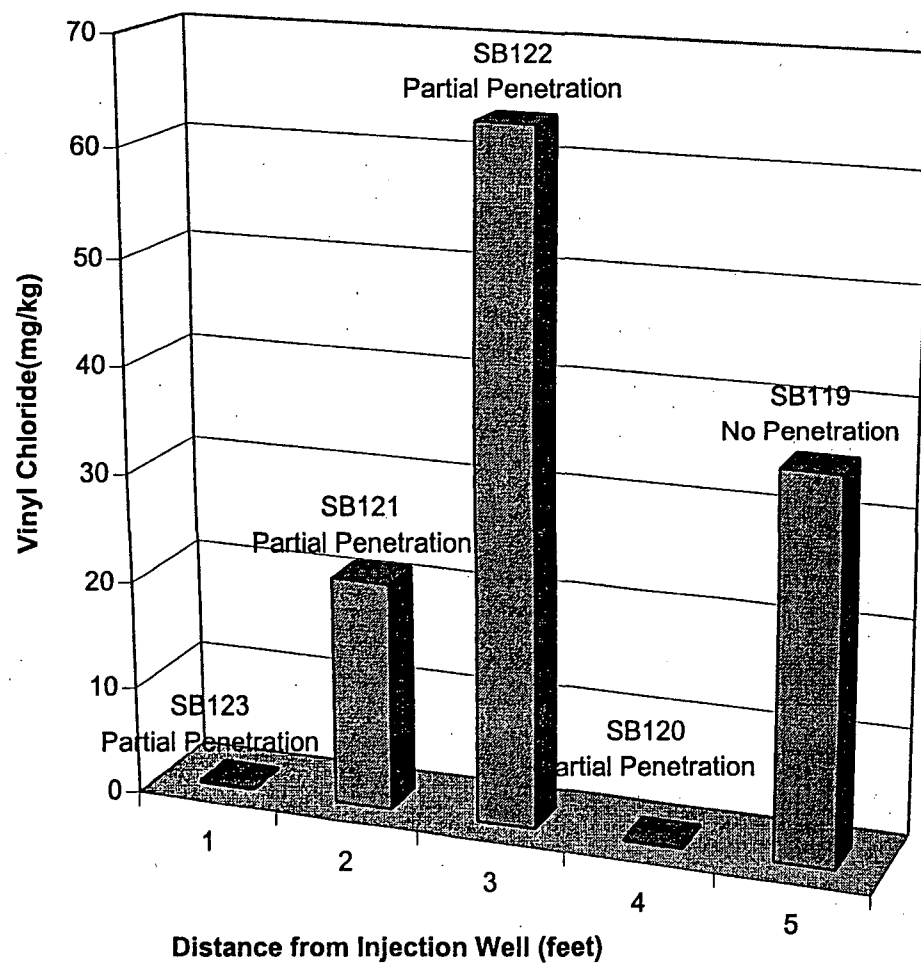
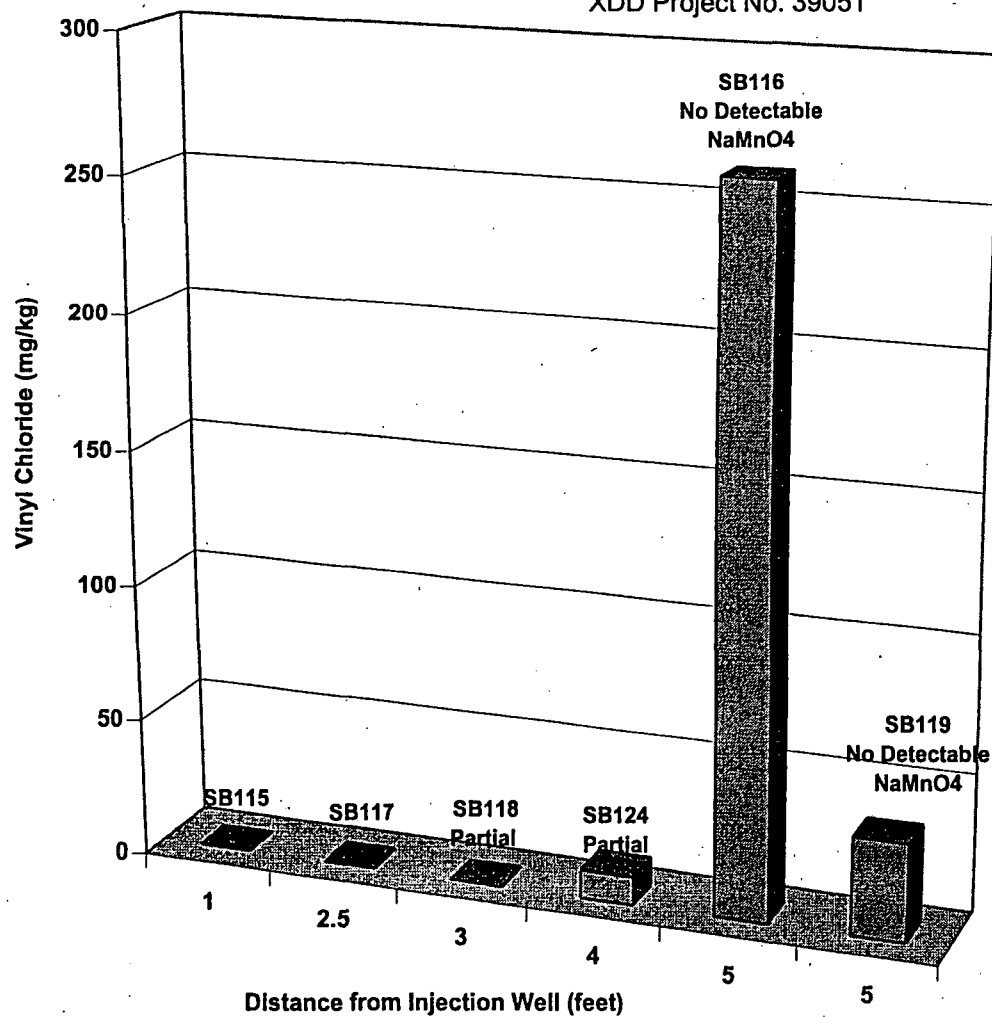


Figure 5A
Soil Vinyl Chloride Concentration vs. Distance from IW-1
 CHEM-OX PILOT TEST - SOLUTIA INDIAN ORCHARD FACILITY, SPRINGFIELD, MA
 XDD Project No. 39051



Note: If NaMnO₄ detected, results shown are for portion of white material layer that was impacted by NaMnO₄.

Figure 5B
Soil Vinyl Chloride Concentration vs. Distance from IW-2
 CHEM-OX PILOT TEST - SOLUTIA INDIAN ORCHARD FACILITY, SPRINGFIELD, MA
 XDD Project No. 39051



Note: If NaMnO4 detected, results shown are for portion of white material layer that was impacted by NaMnO4.

APPENDIX A

Letter to Mr. David Slowick of the MADEP

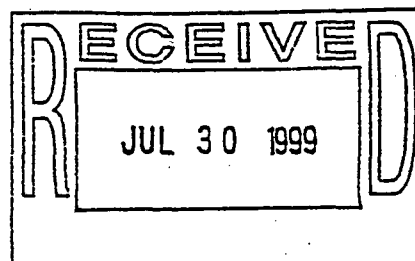


Applied Chemistry, Creative Solutions

Ks
Solutia Inc.
Indian Orchard Plant
730 Worcester Street
Springfield, Massachusetts 01151
Tel 413-788-6911

July 27, 1999

David Slowick
Springfield Office of Massachusetts
Department of Environmental Protection
Section Chief of Emergency Response
436 Dwight Street
Springfield, MA 01103



Re: Solutia Inc.
Indian Orchard Plant
Former Gas Holder Area

Dear Mr. Slowick:

As discussed during your site visit in April 1999, Solutia Inc. (Solutia) plans to implement a pilot study at the Former Gas Holder Area, Indian Orchard Plant in Springfield, MA. This letter serves to notify Massachusetts Department of Environmental Protection (MADEP) of the pilot study and the procedures to monitor and document the pilot study per the Massachusetts Contingency Plan (MCP) 310 Code of Massachusetts Regulation (CMR) 40.0041 - General Provisions for the Management of Remedial Additives and 310 CMR 40.0047 - Reporting Requirements for Discharges for Remedial Additives.

On August 3 and 4, 1999, Xpert Design and Diagnostics, LLC (XDD) of Portsmouth, New Hampshire plans to inject sodium permanganate (an oxidant remedial additive) at two dual screen profilers at approximately 5.5 feet below ground surface. The sodium permanganate was demonstrated in a bench scale study by Environmental Research Institute of Storrs, Connecticut to be effective in the removal of vinyl chloride in a soil sample collected from the site. Sodium permanganate will be injected at a relatively slow rate of approximately 0.5 gallons per minute for approximately 8 hours on August 3, 1999 and for 8 hours on August 4, 1999. To meet the requirements for 310 CMR 40.0045 (1) Requirement for All Discharges to the Ground Surface of Subsurface and/or Ground Water, the rate of injection will be at rate to eliminate the potential for:

- Surficial Erosion and/or Flooding;
- Diversion of Remedial Additive into Utilities; or
- Water Table Does Not Become Mounted More than Two Feet below the Ground Surface.

(Note: Because there are no basements in the near by buildings housing process equipment there is little potential for remedial additive migration into buildings.)

XDD will monitor for sodium permanganate (manganese), temperature, conductivity, and pH at:

- Eighteen monitoring points located 3, 4 and 5 feet laterally away from the two dual screen profilers;
- Six monitoring wells MW-58S, MW-87S, MW-92S, MW-93A and MW-94S (and MW-86S, if accessible); and
- Three storm drains D-223, D-222, and one unlabeled drain.

The 18 monitoring points are located hydraulically upgradient and downgradient of the injection profilers. The monitoring wells are located hydraulically downgradient, and side gradient of the Former Gas Holder Area (Figure 1). Monitoring wells MW-87S, MW-92S and MW-86S are located approximately 50 feet from the injection points and MW-58S, MW-93S and MW-94S are located approximately 200 feet from the injection points. The three storm drains are located hydraulically downgradient of the Former Gas Holder Area.

The 18 monitoring points, 6 monitoring wells and 3 storm drains will be measured for indicator parameters (sodium permanganate, temperature, conductivity and pH) prior to injection of the sodium permanganate. Water levels will be monitored at the injection site at MW-83S and SB-105.

After injection, the 18 monitoring points, three monitoring wells (MW-87S, and MW-92S and, if accessible, MW-86S) and three storm drains will be monitored for the indicator parameters daily on August 3 and August 4, 1999. The 18 monitoring points, six monitoring wells and three storm drains will also be monitored for sodium permanganate, temperature, conductivity and pH once five days after injection and again two weeks after injection. Water levels will also be monitored at MW-83S and SB-105 during each monitoring event for the indicator parameters.

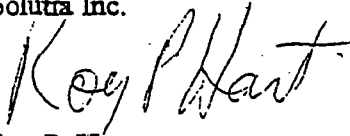
Approximately 10 days after the injection, soil samples will be collected and analyzed for VOCs.

Soil and ground water monitoring activities will be documented with the following per 310 CMR 40.0047:

- Date and Time of Measurement or Sample
- Name of Sampler;
- Specifications of Sampling Method and Preservation;
- Date Laboratory Received the Samples;
- Sample Matrix;
- Analytical Method;
- Result of Analysis;
- Laboratory Detection Limit for Each Constituent for Each Sample;
- Documentation of Potential Quality Assurance Issues;
- Graphical and tabular presentation of any monitoring results; and
- Description of the pilot study design and operation activities.

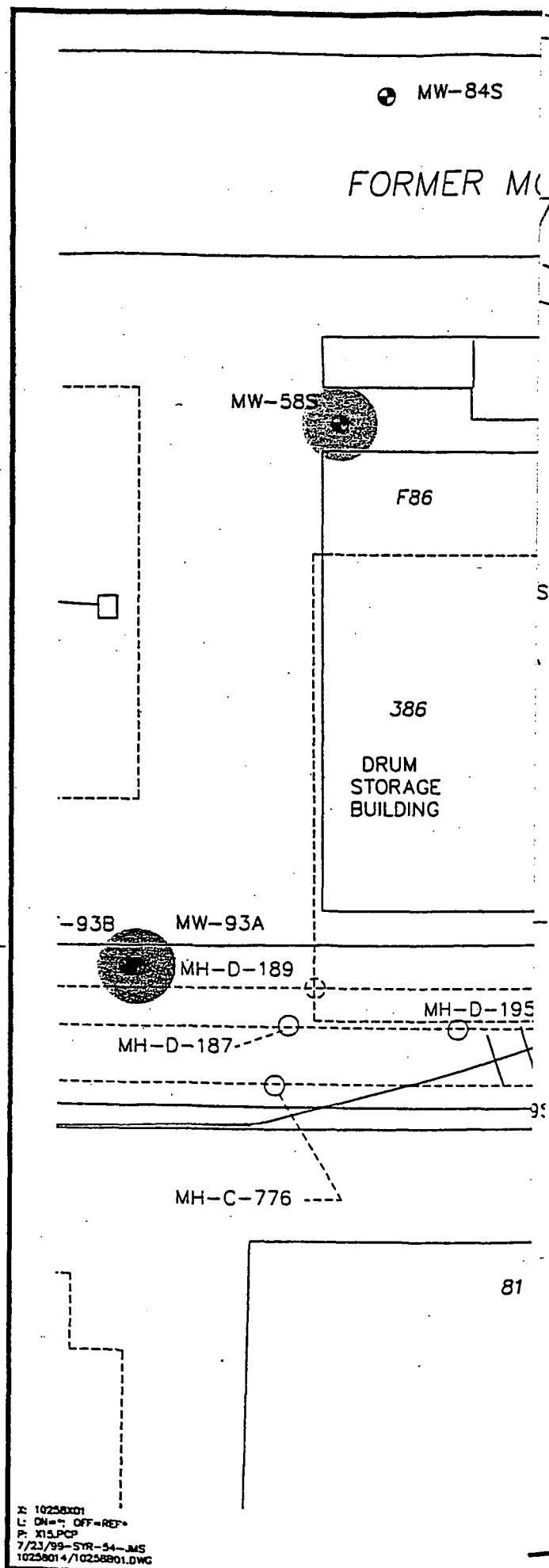
If you have any questions regarding this letter or the pilot study please contact me at (413) 730 -2682.

Sincerely,
Solutia Inc.



Roy P. Hart
Supervisor of Environmental Protection

cc: Mr. Edward Weagle, MADEP
Mr. Raphael J. Cody, USEPA
Mr. Michael L. House, Solutia Inc.
Ms. Caron S. Koll, L.S.P., Blasland Bouck & Lee, Inc.
Mr. Kenneth L. Sperry, P.E., Xpert, Design and Diagnostics, LLC
Mr. Scott C. Crawford, Xpert, Design and Diagnostics, LLC

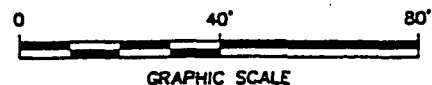


LEGEND

- ⊙ MONITORING WELL
- ▲ SOIL BORING OR DRIVEN WELL
- △ SURFACE SOIL SAMPLE
- INJECTION POINT
- LINE OF MONITORING POINTS AT 2, 3, & 5 FEET FROM INJECTION POINT
- UTILITY MANHOLE
- ADDITIONAL LOCATIONS TO BE MONITORED
- W — UNDERGROUND WATER LINE
- S — UNDERGROUND SEWER
- D — UNDERGROUND STORM DRAIN
- FORMER BUILDING

NOTES

1. BASE MAP PREPARED FROM "BUILDING DESIGNATION PLAN" SUPPLIED BY SOLUTIA INC. 1983, AT A SCALE OF 1" = 200'.
2. THE LOCATION OF BORINGS AND WELLS, ARE SURVEYED BY BBL, BASED ON GRID COORDINATES SUPPLIED BY SOLUTIA INC., EXCEPT FOR FOUNDATION BORINGS (SEE NOTE 5).
3. BUILDINGS, ROADS, AND HYDROGRAPHY SHOULD BE CONSIDERED APPROXIMATE ONLY. FEATURE LOCATIONS ADJUSTED PER SOLUTIA INC. CONSENT ON 11/18/94. FORMER BUILDINGS BASED ON SANBORN MAPS AND SOLUTIA INC. PLANT MAPS PROVIDED 8/8/96. APPROXIMATE UNDERGROUND UTILITY LOCATIONS ADDED 8/98 BASED ON PLANT UTILITY DRAWINGS.
4. ELEVATIONS OF WELLS AND SOIL BORINGS ARE BASED ON SOLUTIA/NOVA CHEMICALS PLANT DATUM (SPD) WHICH IS 0.45' HIGHER THAN USGS NATIONAL GEODETIC VERTICAL DATUM OF 1928.
5. ADDITIONAL BORING LOCATIONS WERE DRILLED FOR GENERAL PLANT (B-72) FROM 1970 THROUGH 1982. SB-57 THROUGH SB-61 WERE DRILLED IN DECEMBER 1994 TO EVALUATE SOILS AND GROUND WATER ASSOCIATED WITH A SEWER. NONE OF THESE BORINGS WERE SURVEYED TO THE PLANT GRID SYSTEM, HOWEVER THEY WERE TIED TO EXISTING UTILITY MANHOLES.
6. SOIL BORING LOCATIONS B-96-08 THROUGH B-96-19 WERE INSTALLED IN OCTOBER 1996 AND ARE APPROXIMATE.
7. THE BANK OF THE RIVER HAS NOT BEEN SURVEYED. RIVER BANK AND RIVER WERE ADJUSTED 15' NORTH TO ACCOMMODATE SURVEYED LOCATIONS.
8. SURVEY OF TEMPORARY WELLS DW-1 THROUGH DW-7 WAS PERFORMED BY HILL ENGINEERS. SURVEY OF MONITORING WELLS TB-1 THROUGH TB-7, MW-615 THROUGH MW-635, AND SB-71 THROUGH SB-108 WERE SURVEYED BY BBL.
9. SURFACE SOIL SAMPLE LOCATIONS ARE APPROXIMATE.
10. SOIL BORINGS (B-96-1 THROUGH B-96-7) ARE APPROXIMATE AND LOCATED BASED ON SITE FEATURES, (EXISTING STYRENE TANK), NOT WELLS (T&S. 1996).



SOLUTIA INC.
EASTERN INDIAN ORCHARD PLANT
SPRINGFIELD, MASSACHUSETTS
FORMER GAS HOLDER AREA PILOT STUDY
**INJECTION AND MONITORING
POINTS LOCATION**

BBL

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE
1

APPENDIX B

Laboratory Analytical Data-Soil VOCs

8/30/1999

The concentrations of VOCs in Soil Samples from Solutia site.

Sample ID	VOCs, µg/kg*			
	Vinyl chloride	cis-1,2-Dichloroethene	1,2 Dicholoroethane	Trichloroethene
SB118 5'2"-5'9"	< 106.9	< 106.9	4,818.4	592.3
SB116 5'3"-6'0"	182,227.9	20,382.5	< 126.8	< 126.8
SB115 5'5"-5'10"	197.8	< 116.4	< 116.4	< 116.4
SB121 5'7.5"-6'0"	132,438.3	< 132.6	2,315.2	610.0
SB121 5'6.5"-5'7.5"	14,794.8	3,877.5	2,489.9	2,237.3
SB120 5'4.5"-5'7"	< 96.2	< 96.2	4,166.2	1,157.7
SB123 5'7.5"-6'0"	< 97.2	< 97.2	1,800.1	562.8
SB122 5'5.5"-6'0"	44,491.7	6,368.4	4,209.7	< 128.1
SB117 5'4"-6'0"	< 127.0	< 127.0	1,857.2	< 127.0
SB124 5'0.5"-5'3"	7,191.1	2,920.4	748.6	2,861.5
SB119 5'4.5"-5'11"	24,606.2	9,199.4	4,002.7	2,249.8
Blank**	< 1	< 1	< 1	< 1

* wet basis

** results are expresses in µg/L.

Environmental Research Institute Laboratory Sample Chain of Custody Sheet

Project Name SOLUTIA, SPRINGFIELD MA
 Contact person KEN SPERRY, XDD
 Mailing address 199 CONSTITUTIONAL BLVD. 1
FORTSMOUTH, NH 03801
 Telephone 603 433 0191
 Fax 603 431 7807
 Bill sent to _____

Environmental Research Institute, Organic Analytical Laboratory
 270 Middle Turnpike
 Room 157, Longley Building U-210
 Storrs, CT 06269-3210
 Telephone 860-486-4015, 860-486-5482
 Fax 860-486-5488

ATTN: TRADEEP
CHHEDA

Report sent to _____

Matrix			Container				Volatile Tests				Semi-volatile Tests				TCLP/SPLP										
water	air	Soil/sediment	animal tissues	1L glass bottle	40 ml VOC vial	8 oz jar (VOC)	16 oz jar (SVOC)	canister	DNPH cartridge	TO-11 Carbonyl	TO-15 VOC	PAMS VOC	VOC 8260	permanent gases	Semi-VOC 8270	Pesticides/PCBs	Herbicides	TPH-GC	TPH-R	PCBs	PAH	VOC	SVOC	Herbicides	Pesticides
		X		X									X		9	9	0	0	0	8	9				
																		0	7	0					
																		0	9	1					
																		0	9	2					
																		0	9	3					
																		0	9	4					
																		0	7	5					
																		0	7	6					
																		0	7	7					
																		0	7	8					
																		0	7	9					
																		1	0	0					

MeOH:
 SOIL
 AFTER 30
 WEIGHT
 (g)

Relinquished by [Signature] Date/time 9/2/99 Received by LFN 9/3/99

Internal Tracking
 Date Prepared _____ Date Analyzed _____ Date Reported _____ Date billed _____ Date Smpl disposed _____
 By _____ By _____ By _____ By _____ By _____

Environmental Research Institute Laboratory Sample Chain of Custody Sheet

Project Name <u>SALUDA</u>	Environmental Research Institute, Organic Analytical Laboratory 270 Middle Turnpike Room 157, Longley Building U-210 Storrs, CT 06269-3210 Telephone 860-486-4015, 860-486-5482 Fax 860-486-5488
Contact person <u>Stephen Newcomb</u>	
Mailing address <u>ERI</u>	
<u>UCOW</u>	
Telephone	
Fax	
Bill sent to	

Report sent to			Matrix						Container						Volatile Tests					Semi-volatile Tests						TCLP/SPLP							
Field ID	Lab ID	Time collected	preserved	not preserved	water	air	Soil/sediment	animal tissues	1L glass bottle	40 ml VOC vial	8 oz jar (VOC)	16 oz jar (SVOC)	canister	DNPH cartridge	TO-11Carbonyl	TO-15 VOC	PAMS VOC	VOC 8260	permanent gases			Semi-VOC 8270	Pesticides/PCBs	Herbicides	TPH -GC	TPH-IR	PCBs	PAH		VOC	SVOC	Herbicides	Pesticides
1990830TRIP	990910	1300/8-30-99			X				-									X															
2																																	
3																																	
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7																																	
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17																																	
18																																	
19																																	
20																																	

Weight
68g

Relinquished by	Date/time	Received by	Internal Tracking				
1 <u>[Signature]</u>		1 <u>LEN 9/3/99</u>	Date Prepared	Date Analyzed	Date Reported	Date billed	Date Smpl disposed
2		2	By	By	By	By	By
3		3					
4		4					

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: SOLUTIA, SPRINGFIELD MA

Sample Identification: 990830TRIP

Reporting Date: 9/9/99

Laboratory Identification: 9909101

Sample Matrix: Soil

Sampling Date: 8/30/99

Report Data File: SSMA990907S.xls

Sample Receiving Date: 9/3/99

Raw Data File: T0907005.D

Date Analyzed: 9/7/99

Method: EPA-8260

CAS Number	Name	Concentration(ug/kg)	MDL (ug/kg)
75-71-8	Dichlorodifluoromethane	ND	1.0
74-87-3	Chloromethane	ND	1.0
75-01-4	Chloroethene(Vinyl Chloride)	ND	1.0
74-83-9	Bromomethane	ND	1.0
75-00-3	Chloroethane	ND	1.0
75-69-4	Trichlorofluoromethane	ND	1.0
75-35-4	1,1-Dichloroethene	ND	1.0
75-09-2	Dichloromethane	ND	1.0
01634-04-4	MTBE	ND	1.0
156-60-5	(E)-1,2-Dichloroethene	ND	1.0
75-34-3	1,1-Dichloroethane	ND	1.0
78-93-3	Methyl Ethyl Ketone (MEK)	ND	1.0
594-20-7	2,2-Dichloropropane	ND	1.0
156-59-2	(Z)-1,2-Dichloroethene	ND	1.0
74-97-5	Bromochloromethane	ND	1.0
67-66-3	Trichloromethane	ND	1.0
71-55-6	1,1,1-Trichloroethane	ND	1.0
563-58-6	1,1-Dichloropropene	ND	1.0
56-23-5	Tetrachloromethane	ND	1.0
71-43-2	Benzene	ND	1.0
107-06-2	1,2-Dichloroethane	ND	1.0
79-01-6	Trichloroethene	ND	1.0
78-87-5	1,2-Dichloropropane	ND	1.0
74-95-3	Dibromomethane	ND	1.0
75-27-4	Bromodichloromethane	ND	1.0
10061-01-5	(Z)-1,3-Dichloropropene	ND	1.0
108-10-1	MIBK	ND	1.0
108-88-3	Toluene	ND	1.0
10061-02-6	(E)-1,3-Dichloropropene	ND	1.0
79-00-5	1,1,2-Trichloroethane	ND	1.0
142-28-9	1,3-Dichloropropane	ND	1.0
127-18-4	Tetrachloroethene	ND	1.0
124-48-1	Dibromochloromethane	ND	1.0
106-93-4	1,2-Dibromoethane	ND	1.0
108-90-7	Chlorobenzene	ND	1.0
630-20-6	1,1,1,2-Tetrachloroethane	ND	1.0
100-41-4	Ethylbenzene	ND	1.0
108-38-3	m-Xylene + p-Xylene	ND	1.0
95-47-6	o-Xylene	ND	1.0
100-42-5	Styrene(ethyl-benzene)	ND	1.0
75-25-2	Bromoform	ND	1.0
98-82-8	iso-Propylbenzene	ND	1.0
79-34-5	1,1,2,2-Tetrachloroethane	ND	1.0
96-18-4	1,2,3-Trichloropropane	ND	1.0
108-86-1	Bromobenzene	ND	1.0
103-65-1	n-Propylbenzene	ND	1.0
108-67-8	1,3,5-Trimethylbenzene	ND	1.0
106-43-4	4-Chlorotoluene	ND	1.0
95-49-8	2-Chlorotoluene	ND	1.0
98-06-9	tert-Butylbenzene	ND	1.0
95-63-6	1,2,4-Trimethylbenzene	ND	1.0
135-98-8	sec-Butylbenzene	ND	1.0
99-87-6	4-iso-Propyltoluene	ND	1.0
541-73-1	1,3-Dichlorobenzene	ND	1.0
106-46-7	1,4-Dichlorobenzene	ND	1.0
104-51-8	n-Butylbenzene	ND	1.0
95-50-1	1,2-Dichlorobenzene	ND	1.0
96-12-8	1,2-Dibromo-3-chloropropane	ND	1.0
120-82-1	1,2,4-Trichlorobenzene	ND	1.0
87-68-3	Hexachlorobutadiene	ND	1.0
91-20-3	Naphthalene	ND	1.0
87-61-6	1,2,3-Trichlorobenzene	ND	1.0
1868-53-7	Dibromofluoromethane(surr1)	42.8	107.0%
107-06-2	1,2-dichloroethane-d4(surr2)	46.5	116.2%
2037-26-5	toluene-d8(surr3)	41.6	104.1%
460-00-4	4-bromofluorobenzene(surr4)	37.4	93.4%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & T. Dai

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: SOLUTIA, SPRINGFIELD MA

Sample Identification: 990830C

Reporting Date: 9/9/99

Laboratory Identification: 9909089

Sample Matrix: Soil

Sampling Date: 8/31/99

Report Data File: SSMA990907S.xls

Sample Receiving Date: 9/3/99

Raw Data File: T0907006.D

Date Analyzed: 9/7/99

Method: EPA-8260

CAS Number	Name	Concentration(ug/kg)	MDL (ug/kg)
75-71-8	Dichlorodifluoromethane	ND	116.4
74-87-3	Chloromethane	ND	116.4
75-01-4	Chloroethene(Vinyl Chloride)	197.8	116.4
74-83-9	Bromomethane	ND	116.4
75-00-3	Chloroethane	ND	116.4
75-69-4	Trichlorofluoromethane	ND	116.4
75-35-4	1,1-Dichloroethene	ND	116.4
75-09-2	Dichloromethane	ND	116.4
01634-04-4	MTBE	ND	116.4
156-60-5	(E)-1,2-Dichloroethene	ND	116.4
75-34-3	1,1-Dichloroethane	ND	116.4
78-93-3	Methyl Ethyl Ketone (MEK)	ND	116.4
594-20-7	2,2-Dichloropropane	ND	116.4
156-59-2	(Z)-1,2-Dichloroethene	ND	116.4
74-97-5	Bromochloromethane	ND	116.4
67-66-3	Trichloromethane	ND	116.4
71-55-6	1,1,1-Trichloroethane	ND	116.4
563-58-6	1,1-Dichloropropene	ND	116.4
56-23-5	Tetrachloromethane	ND	116.4
71-43-2	Benzene	ND	116.4
107-06-2	1,2-Dichloroethane	ND	116.4
79-01-6	Trichloroethene	ND	116.4
78-87-5	1,2-Dichloropropane	ND	116.4
74-95-3	Dibromomethane	ND	116.4
75-27-4	Bromodichloromethane	ND	116.4
10061-01-5	(Z)-1,3-Dichloropropene	ND	116.4
108-10-1	MIBK	ND	116.4
108-88-3	Toluene	ND	116.4
10061-02-6	(E)-1,3-Dichloropropene	ND	116.4
79-00-5	1,1,2-Trichloroethane	ND	116.4
142-28-9	1,3-Dichloropropane	ND	116.4
127-18-4	Tetrachloroethene	ND	116.4
124-48-1	Dibromochloromethane	ND	116.4
106-93-4	1,2-Dibromoethane	ND	116.4
108-90-7	Chlorobenzene	ND	116.4
630-20-6	1,1,1,2-Tetrachloroethane	ND	116.4
100-41-4	Ethylbenzene	ND	116.4
108-38-3	m-Xylene = p-Xylene	ND	116.4
95-47-6	o-Xylene	ND	116.4
100-42-5	Styrene(ethyl-benzene)	ND	116.4
75-25-2	Bromoform	ND	116.4
98-82-8	iso-Propylbenzene	ND	116.4
79-34-5	1,1,2,2-Tetrachloroethane	ND	116.4
96-18-4	1,2,3-Trichloropropane	ND	116.4
108-86-1	Bromobenzene	ND	116.4
103-65-1	n-Propylbenzene	ND	116.4
108-67-8	1,3,5-Trimethylbenzene	ND	116.4
106-43-4	4-Chlorotoluene	ND	116.4
95-49-8	2-Chlorotoluene	ND	116.4
98-06-9	tert-Butylbenzene	ND	116.4
95-63-6	1,2,4-Trimethylbenzene	ND	116.4
135-98-8	sec-Butylbenzene	ND	116.4
99-87-6	4-iso-Propyltoluene	ND	116.4
541-73-1	1,3-Dichlorobenzene	ND	116.4
106-46-7	1,4-Dichlorobenzene	ND	116.4
104-51-8	n-Butylbenzene	ND	116.4
95-50-1	1,2-Dichlorobenzene	ND	116.4
96-12-8	1,2-Dibromo-3-chloropropane	ND	116.4
120-82-1	1,2,4-Trichlorobenzene	ND	116.4
87-68-3	Hexachlorobutadiene	ND	116.4
91-20-3	Naphthalene	ND	116.4
87-61-6	1,2,3-Trichlorobenzene	ND	116.4
1868-53-7	Dibromodifluoromethane(surr1)	41.7	104.2%
107-06-2	1,2-dichloroethane-d4(surr2)	45.7	114.2%
2037-26-5	toluene-d8/surr3)	41.4	103.6%
460-00-4	4-bromodifluorobenzene(surr4)	37.9	94.8%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & T. Dai

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: SOLUTIA, SPRINGFIELD MA

Sample Identification: 990830J

Reporting Date: 9/9/99

Laboratory Identification: 9909090

Sample Matrix: Soil

Sampling Date: 8/31/99

Report Data File: SSMA990907S.xls

Sample Receiving Date: 9/3/99

Raw Data File: T0907007.D

Date Analyzed: 9/7/99

Method: EPA-8260

CAS Number	Name	Concentration(ug/kg)	MDL (ug/kg)
75-71-8	Dichlorodifluoromethane	ND	127.0
74-87-3	Chloromethane	ND	127.0
75-01-4	Chloroethene(Vinyl Chloride)	ND	127.0
74-83-9	Bromomethane	ND	127.0
75-00-3	Chloroethane	ND	127.0
75-69-4	Trichlorofluoromethane	ND	127.0
75-35-4	1,1-Dichloroethene	ND	127.0
75-09-2	Dichloromethane	ND	127.0
01634-04-4	MTBE	ND	127.0
156-60-5	(E)-1,2-Dichloroethene	ND	127.0
75-34-3	1,1-Dichloroethane	ND	127.0
78-93-3	Methyl Ethyl Ketone (MEK)	ND	127.0
594-20-7	2,2-Dichloropropane	ND	127.0
156-59-2	(Z)-1,2-Dichloroethene	ND	127.0
74-97-5	Bromochloromethane	ND	127.0
67-66-3	Trichloromethane	ND	127.0
71-55-6	1,1,1-Trichloroethane	ND	127.0
563-58-6	1,1-Dichloropropene	ND	127.0
56-23-5	Tetrachloromethane	ND	127.0
71-43-2	Benzene	ND	127.0
107-06-2	1,2-Dichloroethane	1857.2	127.0
79-01-6	Trichloroethene	ND	127.0
78-87-5	1,2-Dichloropropane	ND	127.0
74-95-3	Dibromomethane	ND	127.0
75-27-4	Bromodichloromethane	ND	127.0
10061-01-5	(Z)-1,3-Dichloropropene	ND	127.0
108-10-1	MIBK	ND	127.0
108-88-3	Toluene	ND	127.0
10061-02-6	(E)-1,3-Dichloropropene	ND	127.0
79-00-5	1,1,2-Trichloroethane	ND	127.0
142-28-9	1,3-Dichloropropane	ND	127.0
127-18-4	Tetrachloroethene	ND	127.0
124-48-1	Dibromochloromethane	ND	127.0
106-93-4	1,2-Dibromoethane	ND	127.0
108-90-7	Chlorobenzene	ND	127.0
630-20-6	1,1,1,2-Tetrachloroethane	ND	127.0
100-41-4	Ethylbenzene	ND	127.0
108-38-3	m-Xylene + p-Xylene	ND	127.0
95-47-6	o-Xylene	ND	127.0
100-42-5	Styrene(ethyl-benzene)	ND	127.0
75-25-2	Bromoform	ND	127.0
98-82-8	iso-Propylbenzene	ND	127.0
79-34-5	1,1,2,2-Tetrachloroethane	ND	127.0
96-18-4	1,2,3-Trichloropropane	ND	127.0
108-86-1	Bromobenzene	ND	127.0
103-65-1	n-Propylbenzene	ND	127.0
108-67-8	1,3,5-Trimethylbenzene	ND	127.0
106-43-4	4-Chlorotoluene	ND	127.0
95-49-8	2-Chlorotoluene	ND	127.0
98-06-9	tert-Butylbenzene	ND	127.0
95-63-6	1,2,4-Trimethylbenzene	ND	127.0
135-98-8	sec-Butylbenzene	ND	127.0
99-87-6	4-iso-Propyltoluene	ND	127.0
541-73-1	1,3-Dichlorobenzene	ND	127.0
106-46-7	1,4-Dichlorobenzene	ND	127.0
104-51-8	n-Butylbenzene	ND	127.0
95-50-1	1,2-Dichlorobenzene	ND	127.0
96-12-8	1,2-Dibromo-3-chloropropane	ND	127.0
120-82-1	1,2,4-Trichlorobenzene	ND	127.0
87-68-3	Hexachlorobutadiene	ND	127.0
91-20-3	Naphthalene	ND	127.0
87-61-6	1,2,3-Trichlorobenzene	ND	127.0
1868-53-7	Dibromofluoromethane(surr1)	42.9	107.3%
107-06-2	1,2-dichloroethane-d4(surr2)	46.9	117.2%
2037-26-5	toluene-d8(surr3)	41.0	102.5%
460-00-4	4-bromofluorobenzene(surr4)	36.7	91.8%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & T. Dai

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: SOLUTIA, SPRINGFIELD MA

Sample Identification: 990830B

Reporting Date: 9/9/99

Laboratory Identification: 9909091

Sample Matrix: Soil

Sampling Date: 8/31/99

Report Data File: SSMA990907S.xls

Sample Receiving Date: 9/3/99

Raw Data File: T0907008.D

Date Analyzed: 9/7/99

Method: EPA-8260

CAS Number	Name	Concentration(ug/kg)	MDL (ug/kg)
75-71-8	Dichlorodifluoromethane	ND	126.8
74-87-3	Chloromethane	ND	126.8
75-01-4	Chloroethene(Vinyl Chloride)	182227.9	126.8
74-83-9	Bromomethane	ND	126.8
75-00-3	Chloroethane	ND	126.8
75-69-4	Trichlorofluoromethane	ND	126.8
75-35-4	1,1-Dichloroethene	ND	126.8
75-09-2	Dichloromethane	ND	126.8
01634-04-4	MTBE	ND	126.8
156-60-5	(E)-1,2-Dichloroethene	ND	126.8
75-34-3	1,1-Dichloroethane	ND	126.8
78-93-3	Methyl Ethyl Ketone (MEK)	ND	126.8
594-20-7	2,2-Dichloropropane	ND	126.8
156-59-2	(Z)-1,2-Dichloroethene	20382.5	126.8
74-97-5	Bromochloromethane	ND	126.8
67-66-3	Trichloromethane	ND	126.8
71-55-6	1,1,1-Trichloroethane	ND	126.8
563-58-6	1,1-Dichloropropene	ND	126.8
56-23-5	Tetrachloromethane	ND	126.8
71-43-2	Benzene	ND	126.8
107-06-2	1,2-Dichloroethane	ND	126.8
79-01-6	Trichloroethene	ND	126.8
78-87-5	1,2-Dichloropropane	ND	126.8
74-95-3	Dibromomethane	ND	126.8
75-27-4	Bromodichloromethane	ND	126.8
10061-01-5	(Z)-1,3-Dichloropropene	ND	126.8
108-10-1	MIBK	ND	126.8
108-88-3	Toluene	ND	126.8
10061-02-6	(E)-1,3-Dichloropropene	ND	126.8
79-00-5	1,1,2-Trichloroethane	ND	126.8
142-28-9	1,3-Dichloropropane	ND	126.8
127-18-4	Tetrachloroethene	ND	126.8
124-48-1	Dibromochloromethane	ND	126.8
106-93-4	1,2-Dibromoethane	ND	126.8
108-90-7	Chlorobenzene	ND	126.8
630-20-6	1,1,1,2-Tetrachloroethane	ND	126.8
100-41-4	Ethylbenzene	ND	126.8
108-38-3	m-Xylene + p-Xylene	ND	126.8
95-47-6	o-Xylene	ND	126.8
100-42-5	Styrene(ethyl-benzene)	ND	126.8
75-25-2	Bromoform	ND	126.8
98-82-8	iso-Propylbenzene	ND	126.8
79-34-5	1,1,2,2-Tetrachloroethane	ND	126.8
96-18-4	1,2,3-Trichloropropane	ND	126.8
108-86-1	Bromobenzene	ND	126.8
103-65-1	n-Propylbenzene	ND	126.8
108-67-8	1,3,5-Trimethylbenzene	ND	126.8
106-43-4	4-Chlorotoluene	ND	126.8
95-49-8	2-Chlorotoluene	ND	126.8
98-06-9	tert-Butylbenzene	ND	126.8
95-63-6	1,2,4-Trimethylbenzene	ND	126.8
135-98-8	sec-Butylbenzene	ND	126.8
99-87-6	4-iso-Propyltoluene	ND	126.8
541-73-1	1,3-Dichlorobenzene	ND	126.8
106-46-7	1,4-Dichlorobenzene	ND	126.8
104-51-8	n-Butylbenzene	ND	126.8
95-50-1	1,2-Dichlorobenzene	ND	126.8
96-12-8	1,2-Dibromo-3-chloropropane	ND	126.8
120-82-1	1,2,4-Trichlorobenzene	ND	126.8
87-68-3	Hexachlorobutadiene	ND	126.8
91-20-3	Naphthalene	ND	126.8
87-61-6	1,2,3-Trichlorobenzene	ND	126.8
1868-53-7	Dibromofluoromethane(surr1)	42.6	106.6%
107-06-2	1,2-dichloroethane-d4(surr2)	46.9	117.3%
2037-26-5	toluene-d8(surr3)	41.0	102.4%
460-00-4	4-bromofluorobenzene(surr4)	37.6	94.0%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & T.Dai

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: SOLUTIA, SPRINGFIELD MA

Sample Identification: 990830F

Reporting Date: 9/9/99

Laboratory Identification: 9909092

Sample Matrix: Soil

Sampling Date: 9/1/99

Report Data File: SSMA990907S.xls

Sample Receiving Date: 9/3/99

Raw Data File: T0907009.D

Date Analyzed: 9/7/99

Method: EPA-8260

CAS Number	Name	Concentration(ug/kg)	MDL (ug/kg)
75-71-8	Dichlorodifluoromethane	ND	96.2
74-87-3	Chloromethane	ND	96.2
75-01-4	Chloroethane(Vinyl Chloride)	ND	96.2
74-83-9	Bromomethane	ND	96.2
75-00-3	Chloroethane	ND	96.2
75-69-4	Trichlorofluoromethane	ND	96.2
75-35-4	1,1-Dichloroethene	ND	96.2
75-09-2	Dichloromethane	ND	96.2
01634-04-4	MTBE	ND	96.2
156-60-5	(E)-1,2-Dichloroethene	ND	96.2
75-34-3	1,1-Dichloroethane	ND	96.2
78-93-3	Methyl Ethyl Ketone (MEK)	ND	96.2
594-20-7	2,2-Dichloropropane	ND	96.2
156-59-2	(Z)-1,2-Dichloroethene	ND	96.2
74-97-5	Bromochloromethane	ND	96.2
67-66-3	Trichloromethane	ND	96.2
71-55-6	1,1,1-Trichloroethane	ND	96.2
563-58-6	1,1-Dichloropropene	ND	96.2
56-23-5	Tetrachloromethane	ND	96.2
71-43-2	Benzene	ND	96.2
107-06-2	1,2-Dichloroethane	4166.2	96.2
79-01-6	Trichloroethene	1157.7	96.2
78-87-5	1,2-Dichloropropane	ND	96.2
74-95-3	Dibromomethane	ND	96.2
75-27-4	Bromodichloromethane	ND	96.2
10061-01-5	(Z)-1,3-Dichloropropene	ND	96.2
108-10-1	MIBK	ND	96.2
108-88-3	Toluene	ND	96.2
10061-02-6	(E)-1,3-Dichloropropene	ND	96.2
79-00-5	1,1,2-Trichloroethane	ND	96.2
142-28-9	1,3-Dichloropropane	ND	96.2
127-18-4	Tetrachloroethene	ND	96.2
124-48-1	Dibromochloromethane	ND	96.2
106-93-4	1,2-Dibromoethane	ND	96.2
108-90-7	Chlorobenzene	ND	96.2
630-20-6	1,1,1,2-Tetrachloroethane	ND	96.2
100-41-4	Ethylbenzene	ND	96.2
108-38-3	m-Xylene + p-Xylene	ND	96.2
95-47-6	o-Xylene	ND	96.2
100-42-5	Styrene(ethyl-benzene)	ND	96.2
75-25-2	Bromoform	ND	96.2
98-82-8	iso-Propylbenzene	ND	96.2
79-34-5	1,1,2,2-Tetrachloroethane	ND	96.2
96-18-4	1,2,3-Trichloropropane	ND	96.2
108-86-1	Bromobenzene	ND	96.2
103-65-1	n-Propylbenzene	ND	96.2
108-67-8	1,3,5-Trimethylbenzene	ND	96.2
106-43-4	4-Chlorotoluene	ND	96.2
95-49-8	2-Chlorotoluene	ND	96.2
98-06-9	tert-Butylbenzene	ND	96.2
95-63-6	1,2,4-Trimethylbenzene	ND	96.2
135-98-8	sec-Butylbenzene	ND	96.2
99-87-6	4-iso-Propyltoluene	ND	96.2
541-73-1	1,3-Dichlorobenzene	ND	96.2
106-46-7	1,4-Dichlorobenzene	ND	96.2
104-51-8	n-Butylbenzene	ND	96.2
95-50-1	1,2-Dichlorobenzene	ND	96.2
96-12-8	1,2-Dibromo-3-chloropropane	ND	96.2
120-82-1	1,2,4-Trichlorobenzene	ND	96.2
87-68-3	Hexachlorobutadiene	ND	96.2
91-20-3	Naphthalene	ND	96.2
87-61-6	1,2,3-Trichlorobenzene	ND	96.2
1868-33-7	Dibromodifluoromethane(surr1)	42.9	107.3%
107-06-2	1,2-dichloroethane-d4(surr2)	46.1	115.3%
2037-26-5	toluene-d8(surr3)	42.2	105.5%
460-00-4	4-bromofluorobenzene(surr4)	37.4	93.5%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & T.Dai

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: SOLUTIA, SPRINGFIELD MA

Sample Identification: 990830G
Laboratory Identification: 9909093
Sampling Date: 9/1/99
Sample Receiving Date: 9/3/99
Date Analyzed: 9/7/99

Reporting Date: 9/9/99
Sample Matrix: Soil
Report Data File: SSMA990907S.xls
Raw Data File: T0907010.D
Method: EPA-8260

CAS Number	Name	Concentration(ug/kg)	MDL (ug/kg)
75-71-8	Dichlorodifluoromethane	ND	97.2
74-87-3	Chloromethane	ND	97.2
75-01-4	Chloroethene(Vinyl Chloride)	ND	97.2
74-83-9	Bromomethane	ND	97.2
75-00-3	Chloroethane	ND	97.2
75-69-4	Trichlorofluoromethane	ND	97.2
75-35-4	1,1-Dichloroethene	ND	97.2
75-09-2	Dichloromethane	ND	97.2
01634-04-4	MTBE	ND	97.2
156-60-5	(E)-1,2-Dichloroethene	ND	97.2
75-34-3	1,1-Dichloroethane	ND	97.2
78-93-3	Methyl Ethyl Ketone (MEK)	ND	97.2
594-20-7	2,2-Dichloropropane	ND	97.2
156-59-2	(Z)-1,2-Dichloroethene	ND	97.2
74-97-5	Bromochloromethane	ND	97.2
67-66-3	Trichloromethane	ND	97.2
71-55-6	1,1,1-Trichloroethane	ND	97.2
563-58-6	1,1-Dichloropropene	ND	97.2
56-23-5	Tetrachloromethane	ND	97.2
71-43-2	Benzene	ND	97.2
107-06-2	1,2-Dichloroethane	1800.1	97.2
79-01-6	Trichloroethene	562.8	97.2
78-87-5	1,2-Dichloropropane	ND	97.2
74-95-3	Dibromomethane	ND	97.2
75-27-4	Bromodichloromethane	ND	97.2
10061-01-5	(Z)-1,3-Dichloropropene	ND	97.2
108-10-1	MIBK	ND	97.2
108-88-3	Toluene	ND	97.2
10061-02-6	(E)-1,3-Dichloropropene	ND	97.2
79-00-5	1,1,2-Trichloroethane	ND	97.2
142-28-9	1,3-Dichloropropane	ND	97.2
127-18-4	Tetrachloroethene	ND	97.2
124-48-1	Dibromochloromethane	ND	97.2
106-93-4	1,2-Dibromoethane	ND	97.2
108-90-7	Chlorobenzene	ND	97.2
630-20-6	1,1,1,2-Tetrachloroethane	ND	97.2
100-41-4	Ethylbenzene	ND	97.2
108-38-3	m-Xylene + p-Xylene	ND	97.2
95-47-6	o-Xylene	ND	97.2
100-42-5	Styrene(ethyl-benzene)	ND	97.2
75-25-2	Bromoform	ND	97.2
98-82-8	iso-Propylbenzene	ND	97.2
79-34-5	1,1,2,2-Tetrachloroethane	ND	97.2
96-18-4	1,2,3-Trichloropropane	ND	97.2
108-86-1	Bromobenzene	ND	97.2
103-65-1	n-Propylbenzene	ND	97.2
108-67-8	1,3,5-Trimethylbenzene	ND	97.2
106-43-4	4-Chlorotoluene	ND	97.2
95-49-8	2-Chlorotoluene	ND	97.2
98-06-9	tert-Butylbenzene	ND	97.2
95-63-6	1,2,4-Trimethylbenzene	ND	97.2
135-98-8	sec-Butylbenzene	ND	97.2
99-87-6	4-iso-Propyltoluene	ND	97.2
541-73-1	1,3-Dichlorobenzene	ND	97.2
106-46-7	1,4-Dichlorobenzene	ND	97.2
104-51-8	n-Butylbenzene	ND	97.2
95-50-1	1,2-Dichlorobenzene	ND	97.2
96-12-8	1,2-Dibromo-3-chloropropane	ND	97.2
120-82-1	1,2,4-Trichlorobenzene	ND	97.2
87-68-3	Hexachlorobutadiene	ND	97.2
91-20-3	Naphthalene	ND	97.2
87-61-6	1,2,3-Trichlorobenzene	ND	97.2
1868-53-7	Dibromodifluoromethane(surr1)	43.4	108.6%
107-06-2	1,2-dichloroethane-d4(surr2)	45.9	114.8%
2037-26-5	toluene-d8(surr3)	41.6	104.0%
460-00-4	4-bromodifluorobenzene(surr4)	38.0	95.0%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & T.Dai

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: SOLUTIA, SPRINGFIELD MA

Sample Identification: 990830H

Reporting Date:

9/9/99

Laboratory Identification: 9909094

Sample Matrix:

Soil

Sampling Date: 9/1/99

Report Data File:

SSMA990907S.xls

Sample Receiving Date: 9/3/99

Raw Data File:

T0907011.D

Date Analyzed: 9/7/99

Method:

EPA-8260

CAS Number	Name	Concentration(ug/kg)	MDL (ug/kg)
75-71-8	Dichlorodifluoromethane	ND	128.1
74-87-3	Chloromethane	ND	128.1
75-01-4	Chloroethene (Vinyl Chloride)	44491.7	128.1
74-83-9	Bromomethane	ND	128.1
75-00-3	Chloroethane	ND	128.1
75-69-4	Trichlorofluoromethane	ND	128.1
75-35-4	1,1-Dichloroethene	ND	128.1
75-09-2	Dichloromethane	ND	128.1
01634-04-4	MTBE	ND	128.1
156-60-5	(E)-1,2-Dichloroethene	ND	128.1
75-34-3	1,1-Dichloroethane	ND	128.1
78-93-3	Methyl Ethyl Ketone (MEK)	ND	128.1
594-20-7	2,2-Dichloropropane	ND	128.1
156-59-2	(Z)-1,2-Dichloroethene	6368.4	128.1
74-97-5	Bromochloromethane	ND	128.1
67-66-3	Trichloromethane	ND	128.1
71-55-6	1,1,1-Trichloroethane	ND	128.1
563-58-6	1,1-Dichloropropene	ND	128.1
56-23-5	Tetrachloromethane	ND	128.1
71-43-2	Benzene	ND	128.1
107-06-2	1,2-Dichloroethane	4209.7	128.1
79-01-6	Trichloroethene	ND	128.1
78-87-5	1,2-Dichloropropane	ND	128.1
74-95-3	Dibromomethane	ND	128.1
75-27-4	Bromodichloromethane	ND	128.1
10061-01-5	(Z)-1,3-Dichloropropene	ND	128.1
108-10-1	MIBK	ND	128.1
108-88-3	Toluene	ND	128.1
10061-02-6	(E)-1,3-Dichloropropene	ND	128.1
79-00-5	1,1,2-Trichloroethane	ND	128.1
142-28-9	1,3-Dichloropropane	ND	128.1
127-18-4	Tetrachloroethene	ND	128.1
124-48-1	Dibromochloromethane	ND	128.1
106-93-4	1,2-Dibromoethane	ND	128.1
108-90-7	Chlorobenzene	ND	128.1
630-20-6	1,1,1,2-Tetrachloroethane	ND	128.1
100-41-4	Ethylbenzene	ND	128.1
108-38-3	m-Xylene + p-Xylene	ND	128.1
95-47-6	o-Xylene	ND	128.1
100-42-5	Styrene(ethyl-benzene)	ND	128.1
75-25-2	Bromoform	ND	128.1
98-82-8	iso-Propylbenzene	ND	128.1
79-34-5	1,1,2,2-Tetrachloroethane	ND	128.1
96-18-4	1,2,3-Trichloropropane	ND	128.1
108-86-1	Bromobenzene	ND	128.1
103-65-1	n-Propylbenzene	ND	128.1
108-67-8	1,3,5-Trimethylbenzene	ND	128.1
106-43-4	4-Chlorotoluene	ND	128.1
95-49-8	2-Chlorotoluene	ND	128.1
98-06-9	tert-Butylbenzene	ND	128.1
95-63-6	1,2,4-Trimethylbenzene	ND	128.1
135-98-8	sec-Butylbenzene	ND	128.1
99-87-6	4-iso-Propyltoluene	ND	128.1
541-73-1	1,3-Dichlorobenzene	ND	128.1
106-46-7	1,4-Dichlorobenzene	ND	128.1
104-51-8	n-Butylbenzene	ND	128.1
95-50-1	1,2-Dichlorobenzene	ND	128.1
96-12-8	1,2-Dibromo-3-chloropropane	ND	128.1
120-82-1	1,2,4-Trichlorobenzene	ND	128.1
87-68-3	Hexachlorobutadiene	ND	128.1
91-20-3	Naphthalene	ND	128.1
87-61-6	1,2,3-Trichlorobenzene	ND	128.1
1868-33-7	Dibromofluoromethane(surr1)	43.6	108.9%
107-06-2	1,2-dichloroethane-d4(surr2)	46.7	116.8%
2037-26-5	toluene-d8(surr3)	40.9	102.2%
460-00-4	4-bromofluorobenzene(surr4)	37.4	93.6%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & T.Dai

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: SOLUTIA, SPRINGFIELD MA

Sample Identification: 990830L

Reporting Date:

9/9/99

Laboratory Identification: 9909095

Sample Matrix:

Soil

Sampling Date: 9/1/99

Report Data File:

SSMA990907S.xls

Sample Receiving Date: 9/3/99

Raw Data File:

T0907012.D

Date Analyzed: 9/7/99

Method:

EPA-8260

CAS Number	Name	Concentration(ug/kg)	MDL (ug/kg)
75-71-8	Dichlorodifluoromethane	ND	112.4
74-87-3	Chloromethane	ND	112.4
75-01-4	Chloroethene(Vinyl Chloride)	24606.2	112.4
74-83-9	Bromomethane	ND	112.4
75-00-3	Chloroethane	ND	112.4
75-69-4	Trichlorofluoromethane	ND	112.4
75-35-4	1,1-Dichloroethene	ND	112.4
75-09-2	Dichloromethane	ND	112.4
01634-04-4	MTBE	ND	112.4
156-60-5	(E)-1,2-Dichloroethene	ND	112.4
75-34-3	1,1-Dichloroethane	ND	112.4
78-93-3	Methyl Ethyl Ketone (MEK)	ND	112.4
594-20-7	2,2-Dichloropropane	ND	112.4
156-59-2	(Z)-1,2-Dichloroethene	9199.4	112.4
74-97-5	Bromochloromethane	ND	112.4
67-66-3	Trichloromethane	ND	112.4
71-55-6	1,1,1-Trichloroethane	ND	112.4
563-58-6	1,1-Dichloropropene	ND	112.4
56-23-5	Tetrachloromethane	ND	112.4
71-43-2	Benzene	ND	112.4
107-06-2	1,2-Dichloroethane	4002.7	112.4
79-01-6	Trichloroethene	2249.8	112.4
78-87-5	1,2-Dichloropropane	ND	112.4
74-95-3	Dibromomethane	ND	112.4
75-27-4	Bromodichloromethane	ND	112.4
10061-01-5	(Z)-1,3-Dichloropropene	ND	112.4
108-10-1	MIBK	ND	112.4
108-88-3	Toluene	ND	112.4
10061-02-6	(E)-1,3-Dichloropropene	ND	112.4
79-00-5	1,1,2-Trichloroethane	ND	112.4
142-28-9	1,3-Dichloropropane	ND	112.4
127-18-4	Tetrachloroethene	ND	112.4
124-48-1	Dibromochloromethane	ND	112.4
106-93-4	1,2-Dibromoethane	ND	112.4
108-90-7	Chlorobenzene	ND	112.4
630-20-6	1,1,1,2-Tetrachloroethane	ND	112.4
100-41-4	Ethylbenzene	ND	112.4
108-38-3	m-Xylene + p-Xylene	ND	112.4
95-47-6	o-Xylene	ND	112.4
100-42-5	Styrene(ethyl-benzene)	ND	112.4
75-25-2	Bromoform	ND	112.4
98-82-8	iso-Propylbenzene	ND	112.4
79-34-5	1,1,2,2-Tetrachloroethane	ND	112.4
96-18-4	1,2,3-Trichloropropane	ND	112.4
108-86-1	Bromobenzene	ND	112.4
103-65-1	n-Propylbenzene	ND	112.4
108-67-8	1,3,5-Trimethylbenzene	ND	112.4
106-43-4	4-Chlorotoluene	ND	112.4
95-49-8	2-Chlorotoluene	ND	112.4
98-06-9	tert-Butylbenzene	ND	112.4
95-63-6	1,2,4-Trimethylbenzene	ND	112.4
135-98-8	sec-Butylbenzene	ND	112.4
99-87-6	4-iso-Propyltoluene	ND	112.4
541-73-1	1,3-Dichlorobenzene	ND	112.4
106-46-7	1,4-Dichlorobenzene	ND	112.4
104-51-8	n-Butylbenzene	ND	112.4
95-50-1	1,2-Dichlorobenzene	ND	112.4
96-12-8	1,2-Dibromo-3-chloropropane	ND	112.4
120-82-1	1,2,4-Trichlorobenzene	ND	112.4
87-68-3	Hexachlorobutadiene	ND	112.4
91-20-3	Naphthalene	ND	112.4
87-61-6	1,2,3-Trichlorobenzene	ND	112.4
1868-53-7	Dibromofluoromethane(surr1)	44.1	110.2%
107-06-2	1,2-dichloroethane-d4(surr2)	47.2	118.0%
2037-26-5	toluene-d8(surr3)	41.6	104.1%
460-00-4	4-bromofluorobenzene(surr4)	38.4	95.9%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & T.Dai

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: SOLUTIA, SPRINGFIELD MA

Sample Identification: 990830E

Reporting Date:

9/9/99

Laboratory Identification: 9909098

Sample Matrix:

Soil

Sampling Date: 9/1 99

Report Data File:

SSMA990907S.xls

Sample Receiving Date: 9/3 99

Raw Data File:

T0907015.D

Date Analyzed: 9/8 99

Method:

EPA-8260

CAS Number	Name	Concentration(ug/kg)	MDL (ug/kg)
75-71-8	Dichlorodifluoromethane	ND	109.3
74-87-3	Chloromethane	ND	109.3
75-01-4	Chloroethene(Vinyl Chloride)	14794.8	109.3
74-83-9	Bromomethane	ND	109.3
75-00-3	Chloroethane	ND	109.3
75-69-4	Trichlorofluoromethane	ND	109.3
75-35-4	1,1-Dichloroethene	ND	109.3
75-09-2	Dichloromethane	ND	109.3
01634-04-4	MTBE	ND	109.3
156-60-5	(E)-1,2-Dichloroethene	ND	109.3
75-34-3	1,1-Dichloroethane	ND	109.3
78-93-3	Methyl Ethyl Ketone (MEK)	ND	109.3
594-20-7	2,2-Dichloropropane	ND	109.3
156-59-2	(Z)-1,2-Dichloroethene	3877.5	109.3
74-97-5	Bromochloromethane	ND	109.3
67-66-3	Trichloromethane	ND	109.3
71-55-6	1,1,1-Trichloroethane	ND	109.3
563-58-6	1,1-Dichloropropene	ND	109.3
56-23-5	Tetrachloromethane	ND	109.3
71-43-2	Benzene	ND	109.3
107-06-2	1,2-Dichloroethane	2489.9	109.3
79-01-6	Trichloroethene	2237.3	109.3
78-87-5	1,2-Dichloropropane	ND	109.3
74-95-3	Dibromomethane	ND	109.3
75-27-4	Bromodichloromethane	ND	109.3
10061-01-5	(Z)-1,3-Dichloropropene	ND	109.3
108-10-1	MIBK	ND	109.3
108-88-3	Toluene	ND	109.3
10061-02-6	(E)-1,3-Dichloropropene	ND	109.3
79-00-5	1,1,2-Trichloroethane	ND	109.3
142-28-9	1,3-Dichloropropane	ND	109.3
127-18-4	Tetrachloroethene	ND	109.3
124-48-1	Dibromochloromethane	ND	109.3
106-93-4	1,2-Dibromoethane	ND	109.3
108-90-7	Chlorobenzene	ND	109.3
630-20-6	1,1,1,2-Tetrachloroethane	ND	109.3
100-41-4	Ethylbenzene	ND	109.3
108-38-3	m-Xylene + p-Xylene	ND	109.3
95-47-6	o-Xylene	ND	109.3
100-42-5	Styrene(ethyl-benzene)	ND	109.3
75-25-2	Bromoform	ND	109.3
98-82-8	iso-Propylbenzene	ND	109.3
79-34-3	1,1,2,2-Tetrachloroethane	ND	109.3
96-18-4	1,2,3-Trichloropropane	ND	109.3
108-86-1	Bromobenzene	ND	109.3
103-65-1	n-Propylbenzene	ND	109.3
108-67-8	1,3,5-Trimethylbenzene	ND	109.3
106-43-4	4-Chlorotoluene	ND	109.3
95-49-8	2-Chlorotoluene	ND	109.3
98-06-9	tert-Butylbenzene	ND	109.3
95-63-6	1,2,4-Trimethylbenzene	ND	109.3
135-98-8	sec-Butylbenzene	ND	109.3
99-87-6	4-iso-Propyltoluene	ND	109.3
541-73-1	1,3-Dichlorobenzene	ND	109.3
106-46-7	1,4-Dichlorobenzene	ND	109.3
104-51-8	n-Butylbenzene	ND	109.3
95-50-1	1,2-Dichlorobenzene	ND	109.3
96-12-8	1,2-Dibromo-3-chloropropane	ND	109.3
120-82-1	1,2,4-Trichlorobenzene	ND	109.3
87-68-3	Hexachlorobutadiene	ND	109.3
91-20-3	Naphthalene	ND	109.3
87-61-6	1,2,3-Trichlorobenzene	ND	109.3
1868-33-7	Dibromofluoromethane(surr1)	43.1	107.9%
107-06-2	1,2-dichloroethane-d4(surr2)	46.6	116.5%
2037-26-5	toluene-d8(surr3)	41.0	102.5%
460-00-4	4-bromofluorobenzene(surr4)	38.6	96.5%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & T. Dai

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: SOLUTIA, SPRINGFIELD MA

Sample Identification: 990830K

Reporting Date:

9/9/99

Laboratory Identification: 9909096

Sample Matrix:

Soil

Sampling Date: 9/1/99

Report Data File:

SSMA990907S.xls

Sample Receiving Date: 9/3/99

Raw Data File:

T0907013.D

Date Analyzed: 9/8/99

Method:

EPA-8260

CAS Number	Name	Concentration(ug/kg)	MDL (ug/kg)
75-71-8	Dichlorodifluoromethane	ND	93.6
74-87-3	Chloromethane	ND	93.6
75-01-4	Chloroethene(Vinyl Chloride)	7191.1	93.6
74-83-9	Bromomethane	ND	93.6
75-00-3	Chloroethane	ND	93.6
75-69-4	Trichlorofluoromethane	ND	93.6
75-35-4	1,1-Dichloroethene	ND	93.6
75-09-2	Dichloromethane	ND	93.6
01634-04-4	MTBE	ND	93.6
156-60-3	(E)-1,2-Dichloroethene	ND	93.6
75-34-3	1,1-Dichloroethane	ND	93.6
78-93-3	Methyl Ethyl Ketone (MEK)	ND	93.6
594-20-7	2,2-Dichloropropane	ND	93.6
156-59-2	(Z)-1,2-Dichloroethene	2920.4	93.6
74-97-5	Bromochloromethane	ND	93.6
67-66-3	Trichloromethane	ND	93.6
71-55-6	1,1,1-Trichloroethane	ND	93.6
563-58-6	1,1-Dichloropropene	ND	93.6
56-23-5	Tetrachloromethane	ND	93.6
71-43-2	Benzene	ND	93.6
107-06-2	1,2-Dichloroethane	748.6	93.6
79-01-6	Trichloroethene	2861.5	93.6
78-87-5	1,2-Dichloropropane	ND	93.6
74-95-3	Dibromomethane	ND	93.6
75-27-4	Bromodichloromethane	ND	93.6
10061-01-5	(Z)-1,3-Dichloropropene	ND	93.6
108-10-1	MIBK	ND	93.6
108-88-3	Toluene	ND	93.6
10061-02-6	(E)-1,3-Dichloropropene	ND	93.6
79-00-5	1,1,2-Trichloroethane	ND	93.6
142-28-9	1,3-Dichloropropane	ND	93.6
127-18-4	Tetrachloroethene	ND	93.6
124-48-1	Dibromochloromethane	ND	93.6
106-93-4	1,2-Dibromoethane	ND	93.6
108-90-7	Chlorobenzene	ND	93.6
630-20-6	1,1,1,2-Tetrachloroethane	ND	93.6
100-41-4	Ethylbenzene	ND	93.6
108-38-3	m-Xylene + p-Xylene	ND	93.6
95-47-6	o-Xylene	ND	93.6
100-42-5	Styrene(ethyl-benzene)	ND	93.6
75-25-2	Bromoform	ND	93.6
98-82-8	iso-Propylbenzene	ND	93.6
79-34-5	1,1,2,2-Tetrachloroethane	ND	93.6
96-18-4	1,2,3-Trichloropropane	ND	93.6
108-86-1	Bromobenzene	ND	93.6
103-65-1	n-Propylbenzene	ND	93.6
108-67-8	1,3,5-Trimethylbenzene	ND	93.6
106-43-4	4-Chlorotoluene	ND	93.6
95-49-8	2-Chlorotoluene	ND	93.6
98-06-9	tert-Butylbenzene	ND	93.6
95-63-6	1,2,4-Trimethylbenzene	ND	93.6
135-98-8	sec-Butylbenzene	ND	93.6
99-87-6	4-iso-Propyltoluene	ND	93.6
541-73-1	1,3-Dichlorobenzene	ND	93.6
106-46-7	1,4-Dichlorobenzene	ND	93.6
104-51-8	n-Butylbenzene	ND	93.6
95-50-1	1,2-Dichlorobenzene	ND	93.6
96-12-8	1,2-Dibromo-3-chloropropane	ND	93.6
120-82-1	1,2,4-Trichlorobenzene	ND	93.6
87-68-3	Hexachlorobutadiene	ND	93.6
91-20-3	Naphthalene	ND	93.6
87-61-6	1,2,3-Trichlorobenzene	ND	93.6
1868-53-7	Dibromodifluoromethane(surr1)	44.8	112.1%
107-06-2	1,2-dichloroethane-d4(surr2)	46.7	116.8%
2037-26-3	toluene-d8(surr3)	42.1	105.3%
460-00-4	4-bromofluorobenzene(surr4)	38.0	95.1%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & T. Dai

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: SOLUTIA, SPRINGFIELD MA

Sample Identification: 990830A

Reporting Date:

9/9/99

Laboratory Identification: 9909097

Sample Matrix:

Soil

Sampling Date: 9/1/99

Report Data File:

SSMA990907S.xls

Sample Receiving Date: 9/3/99

Raw Data File:

T0907014.D

Date Analyzed: 9/8/99

Method:

EPA-8260

CAS Number	Name	Concentration(ug/kg)	MDL (ug/kg)
75-71-8	Dichlorodifluoromethane	ND	106.9
74-87-3	Chloromethane	ND	106.9
75-01-4	Chloroethene(Vinyl Chloride)	ND	106.9
74-83-9	Bromomethane	ND	106.9
75-00-3	Chloroethane	ND	106.9
75-69-4	Trichlorofluoromethane	ND	106.9
75-35-4	1,1-Dichloroethene	ND	106.9
75-09-2	Dichloromethane	ND	106.9
01634-04-4	MTBE	ND	106.9
156-60-3	(E)-1,2-Dichloroethene	ND	106.9
75-34-3	1,1-Dichloroethane	ND	106.9
78-93-3	Methyl Ethyl Ketone (MEK)	ND	106.9
594-20-7	2,2-Dichloropropane	ND	106.9
156-59-2	(Z)-1,2-Dichloroethene	ND	106.9
74-97-5	Bromochloromethane	ND	106.9
67-66-3	Trichloromethane	ND	106.9
71-55-6	1,1,1-Trichloroethane	ND	106.9
563-58-6	1,1-Dichloropropene	ND	106.9
56-23-5	Tetrachloromethane	ND	106.9
71-43-2	Benzene	ND	106.9
107-06-2	1,2-Dichloroethane	4818.4	106.9
79-01-6	Trichloroethene	592.3	106.9
78-87-5	1,2-Dichloropropane	ND	106.9
74-95-3	Dibromomethane	ND	106.9
75-27-4	Bromodichloromethane	ND	106.9
10061-01-5	(Z)-1,3-Dichloropropene	ND	106.9
108-10-1	MIBK	ND	106.9
108-88-3	Toluene	ND	106.9
10061-02-6	(E)-1,3-Dichloropropene	ND	106.9
79-00-5	1,1,2-Trichloroethane	ND	106.9
142-28-9	1,3-Dichloropropane	ND	106.9
127-18-4	Tetrachloroethene	ND	106.9
124-48-1	Dibromochloromethane	ND	106.9
106-93-4	1,2-Dibromoethane	ND	106.9
108-90-7	Chlorobenzene	ND	106.9
630-20-6	1,1,1,2-Tetrachloroethane	ND	106.9
100-41-4	Ethylbenzene	ND	106.9
108-38-3	m-Xylene + p-Xylene	ND	106.9
95-47-6	o-Xylene	ND	106.9
100-42-5	Styrene(ethyl-benzene)	ND	106.9
75-25-2	Bromoform	ND	106.9
98-82-8	iso-Propylbenzene	ND	106.9
79-34-5	1,1,2,2-Tetrachloroethane	ND	106.9
96-18-4	1,2,3-Trichloropropane	ND	106.9
108-86-1	Bromobenzene	ND	106.9
103-65-1	n-Propylbenzene	ND	106.9
108-67-8	1,3,5-Trimethylbenzene	ND	106.9
106-43-4	4-Chlorotoluene	ND	106.9
95-49-8	2-Chlorotoluene	ND	106.9
98-06-9	tert-Butylbenzene	ND	106.9
95-63-6	1,2,4-Trimethylbenzene	ND	106.9
135-98-8	sec-Butylbenzene	ND	106.9
99-87-6	4-iso-Propyltoluene	ND	106.9
541-73-1	1,3-Dichlorobenzene	ND	106.9
106-46-7	1,4-Dichlorobenzene	ND	106.9
104-51-8	n-Butylbenzene	ND	106.9
95-50-1	1,2-Dichlorobenzene	ND	106.9
96-12-8	1,2-Dibromo-3-chloropropane	ND	106.9
120-82-1	1,2,4-Trichlorobenzene	ND	106.9
87-68-3	Hexachlorobutadiene	ND	106.9
91-20-3	Naphthalene	ND	106.9
87-61-6	1,2,3-Trichlorobenzene	ND	106.9
1868-33-7	Dibromofluoromethane(surr1)	43.1	107.7%
107-06-2	1,2-dichloroethane-d4(surr2)	47.4	118.4%
2037-26-5	toluene-d8(surr3)	41.0	102.5%
460-00-4	4-bromofluorobenzene(surr4)	38.0	95.1%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & T. Dai

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: SOLUTIA, SPRINGFIELD MA

Sample Identification: 990830D

Reporting Date: 9/9/99

Laboratory Identification: 9909099

Sample Matrix: Soil

Sampling Date: 9/1/99

Report Data File: SSMA990907S.xls

Sample Receiving Date: 9/3/99

Raw Data File: T0907016.D

Date Analyzed: 9/8/99

Method: EPA-8260

CAS Number	Name	Concentration(ug/kg)	MDL (ug/kg)
75-71-8	Dichlorodifluoromethane	ND	132.6
74-87-3	Chloromethane	ND	132.6
75-01-4	Chloroethene(Vinyl Chloride)	132438.3	132.6
74-83-9	Bromomethane	ND	132.6
75-00-3	Chloroethane	ND	132.6
75-69-4	Trichlorofluoromethane	ND	132.6
75-35-4	1,1-Dichloroethene	ND	132.6
75-09-2	Dichloromethane	ND	132.6
01634-04-4	MTBE	ND	132.6
156-60-5	(E)-1,2-Dichloroethene	ND	132.6
75-34-3	1,1-Dichloroethane	ND	132.6
78-93-3	Methyl Ethyl Ketone (MEK)	ND	132.6
594-20-7	2,2-Dichloropropane	ND	132.6
156-59-2	(Z)-1,2-Dichloroethene	ND	132.6
74-97-5	Bromochloromethane	ND	132.6
67-66-3	Trichloromethane	ND	132.6
71-55-6	1,1,1-Trichloroethane	ND	132.6
563-58-6	1,1-Dichloropropene	ND	132.6
56-23-5	Tetrachloromethane	ND	132.6
71-43-2	Benzene	ND	132.6
107-06-2	1,2-Dichloroethane	2315.2	132.6
79-01-6	Trichloroethene	610.0	132.6
78-87-5	1,2-Dichloropropane	ND	132.6
74-95-3	Dibromomethane	ND	132.6
75-27-4	Bromodichloromethane	ND	132.6
10061-01-5	(Z)-1,3-Dichloropropene	ND	132.6
108-10-1	MIBK	ND	132.6
108-88-3	Toluene	ND	132.6
10061-02-6	(E)-1,3-Dichloropropene	ND	132.6
79-00-5	1,1,2-Trichloroethane	ND	132.6
142-28-9	1,3-Dichloropropane	ND	132.6
127-18-4	Tetrachloroethene	ND	132.6
124-48-1	Dibromochloromethane	ND	132.6
106-93-4	1,2-Dibromoethane	ND	132.6
108-90-7	Chlorobenzene	ND	132.6
630-20-6	1,1,1,2-Tetrachloroethane	ND	132.6
100-41-4	Ethylbenzene	ND	132.6
108-38-3	m-Xylene + p-Xylene	ND	132.6
95-47-6	o-Xylene	ND	132.6
100-42-5	Styrene(ethyl-benzene)	ND	132.6
75-25-2	Bromoform	ND	132.6
98-82-8	iso-Propylbenzene	ND	132.6
79-34-5	1,1,2,2-Tetrachloroethane	ND	132.6
96-18-4	1,2,3-Trichloropropane	ND	132.6
108-86-1	Bromobenzene	ND	132.6
103-65-1	n-Propylbenzene	ND	132.6
108-67-8	1,3,5-Trimethylbenzene	ND	132.6
106-43-4	4-Chlorotoluene	ND	132.6
95-49-8	2-Chlorotoluene	ND	132.6
98-06-9	tert-Butylbenzene	ND	132.6
95-63-6	1,2,4-Trimethylbenzene	ND	132.6
135-98-8	sec-Butylbenzene	ND	132.6
99-87-6	4-iso-Propyltoluene	ND	132.6
541-73-1	1,3-Dichlorobenzene	ND	132.6
106-46-7	1,4-Dichlorobenzene	ND	132.6
104-51-8	n-Butylbenzene	ND	132.6
95-50-1	1,2-Dichlorobenzene	ND	132.6
96-12-8	1,2-Dibromo-3-chloropropane	ND	132.6
120-82-1	1,2,4-Trichlorobenzene	ND	132.6
87-68-3	Hexachlorobutadiene	ND	132.6
91-20-3	Naphthalene	ND	132.6
87-61-6	1,2,3-Trichlorobenzene	ND	132.6
1868-53-7	Dibromodifluoromethane(surr1)	41.8	109.6%
107-06-2	1,2-dichloroethane-d4(surr2)	47.4	118.6%
2037-26-5	toluene-d8(surr3)	42.0	105.1%
460-00-4	4-bromofluorobenzene(surr4)	38.3	95.8%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & T.Dai

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: SOLUTIA, SPRINGFIELD MA

Sample Identification: 9908301

Reporting Date: 9/9/99

Laboratory Identification: 9909100

Sample Matrix: Soil

Sampling Date: 9/1/99

Report Data File: \SSMA990907S.xls

Sample Receiving Date: 9/3/99

Raw Data File: T0907018.D

Date Analyzed: 9/8/99

Method: EPA-8260

CAS Number	Name	Concentration(ug/kg)	MDL (ug/kg)
75-71-8	Dichlorodifluoromethane	ND	101.7
74-87-3	Chloromethane	ND	101.7
75-01-4	Chloroethene(Vinyl Chloride)	ND	101.7
74-83-9	Bromomethane	ND	101.7
75-00-3	Chloroethane	ND	101.7
75-69-4	Trichlorofluoromethane	ND	101.7
75-35-4	1,1-Dichloroethene	ND	101.7
75-09-2	Dichloromethane	ND	101.7
01634-04-4	MTBE	ND	101.7
156-60-5	(E)-1,2-Dichloroethene	ND	101.7
75-34-3	1,1-Dichloroethane	ND	101.7
78-93-3	Methyl Ethyl Ketone (MEK)	ND	101.7
594-20-7	2,2-Dichloropropane	ND	101.7
156-59-2	(Z)-1,2-Dichloroethene	ND	101.7
74-97-5	Bromochloromethane	ND	101.7
67-66-3	Trichloromethane	ND	101.7
71-55-6	1,1,1-Trichloroethane	ND	101.7
563-58-6	1,1-Dichloropropene	ND	101.7
56-23-5	Tetrachloromethane	ND	101.7
71-43-2	Benzene	ND	101.7
107-06-2	1,2-Dichloroethane	ND	101.7
79-01-6	Trichloroethene	ND	101.7
78-87-5	1,2-Dichloropropane	ND	101.7
74-95-3	Dibromomethane	ND	101.7
75-27-4	Bromodichloromethane	ND	101.7
10061-01-5	(Z)-1,3-Dichloropropene	ND	101.7
108-10-1	MIBK	ND	101.7
108-88-3	Toluene	ND	101.7
10061-02-6	(E)-1,3-Dichloropropene	ND	101.7
79-00-5	1,1,2-Trichloroethane	ND	101.7
142-28-9	1,3-Dichloropropane	ND	101.7
127-18-4	Tetrachloroethene	ND	101.7
124-48-1	Dibromochloromethane	ND	101.7
106-93-4	1,2-Dibromoethane	ND	101.7
108-90-7	Chlorobenzene	ND	101.7
630-20-6	1,1,1,2-Tetrachloroethane	ND	101.7
100-41-4	Ethylbenzene	ND	101.7
108-38-3	m-Xylene + p-Xylene	ND	101.7
95-47-6	o-Xylene	ND	101.7
100-42-5	Styrene(ethyl-benzene)	ND	101.7
75-25-2	Bromoform	ND	101.7
98-82-8	iso-Propylbenzene	ND	101.7
79-34-5	1,1,2,2-Tetrachloroethane	ND	101.7
96-18-4	1,2,3-Trichloropropane	ND	101.7
108-86-1	Bromobenzene	ND	101.7
103-65-1	n-Propylbenzene	ND	101.7
108-67-8	1,3,5-Trimethylbenzene	ND	101.7
106-43-4	4-Chlorotoluene	ND	101.7
95-49-8	2-Chlorotoluene	ND	101.7
98-06-9	tert-Butylbenzene	ND	101.7
95-63-6	1,2,4-Trimethylbenzene	ND	101.7
135-98-8	sec-Butylbenzene	ND	101.7
99-87-6	4-iso-Propyltoluene	ND	101.7
541-73-1	1,3-Dichlorobenzene	ND	101.7
106-46-7	1,4-Dichlorobenzene	ND	101.7
104-51-8	n-Butylbenzene	ND	101.7
95-50-1	1,2-Dichlorobenzene	ND	101.7
96-12-8	1,2-Dibromo-3-chloropropane	ND	101.7
120-82-1	1,2,4-Trichlorobenzene	ND	101.7
87-68-3	Hexachlorobutadiene	ND	101.7
91-20-3	Naphthalene	ND	101.7
87-61-6	1,2,3-Trichlorobenzene	ND	101.7
1868-53-7	Dibromofluoromethane(surr1)	42.8	106.9%
107-06-2	1,2-dichloroethane-d4(surr2)	46.6	116.5%
2037-26-5	toluene-d8(surr3)	42.9	107.4%
460-00-4	4-bromofluorobenzene(surr4)	37.9	94.6%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & T. Dai

7/16/1999

The concentrations of VOCs in Soil Samples from Solutia site.

Sample ID	VOCs, mg/kg*			
	Vinyl chloride	cis-1,2-Dichloroethene	1,2 Dicholoroethane	Trichloroethene
SB 111	489	63.3	< 2.1	< 2.1
SB 112	272	58.4	18.0	2.71
SB 113	368	50.3	< 2.0	10.7
SB 114	300	62.1	< 1.7	< 1.7
Blank**	< 1.0	< 1.0	< 1.0	< 1.0

* wet basis

** results are expresses in µg/L.

VOLATILE ORGANICS CHAIN OF CUSTODY

Name of Project: Solutia-XDD
 Sample Collector: Scott Crawford
 Client Name: _____
 Client Address: _____

ENVIRONMENTAL RESEARCH INSTITUTE
 The Longley Building, Route 44, u-210
 Storrs, Connecticut 06269-3210
 Phone: (860) 486-2858 Fax: (860) 486-5488

Phone: _____
 Fax: _____

SDG: _____
 Location Code: _____

Circle one: If "Yes", explain:

Toxic?	Yes	No	Unknown	
Special Care?	Yes	No	Unknown	
Sample Preserved?	<u>Yes</u>	No	Unknown	ICE/MeOH
Sample Type?	liquid	Solid	Other	

	Relinquished By (Signature):	Received By (Signature):	Date:	Time:	Storage Location:
Delivery	<u>Scott Crawford</u>		7/14/99		
Preparation	<u>X. Wang</u>	<u>X. Wang</u>	7/15/99	11:00	
Analysis	<u>X. Wang</u>		7/16/99		
Quality Control					
Data Report	<u>X. Wang</u>		7/17/99		
Disposal					

LIM NUMBER	FIELD NUMBER	COLLECTION DATE	TIME	COMMENTS
1	SP-728Y	SB-111 6.0-6.5	7/13/99	Bottle 1: empty 25.4864 bottle + MeOH 45.2317
2	290	SB-112 5.5-6.0		Bottle 2: empty 25.2777 bottle + MeOH 45.2235
3	291	SB-113 5.7-6.0		Bottle 3: empty 25.4606 bottle + MeOH 45.0203
4	292	SB-114 5.5-6.0		Bottle 4: empty 25.1803 bottle + MeOH 44.7693
5	293	BLANK		Bottle 5: W-ter + 1 drop HCl
6				
7				bottle + MeOH w/sample
8				BOTTLE 1: 1.60.02 2.35.02
9				2: 1.55.02 2.30.02
10				3: 1.55.02 2.50.02
11				4: 1.55.02 2.75.02
12				
13				B+M + Sample
14				1: 67.4373
15				2: 65.3430
16				3: 70.1847
17				4: 78.6541
18				
19				
20				

ANALYSIS: Circle Desired Test Parameters

GC/MSD II: VOLATILES (WATER SOIL)

GC/MSD III: VOLATILES (AIR)

HPLC II: CARBONYL

PREPS: TCLP

Vinyl Chloride
~ ppm

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: Solutia-XDD

Sample Identification: 9907293, BLANK

Laboratory Identification: NA

Sampling Date: 7/13/99

Sample Receiving Date: 7/15/99

Date Analyzed: 07/16/19 -1:1:

Reporting Date:

7/17/99

Sample Matrix:

Aqueous

Report Data File:

SXDD990714W.XLS

Raw Data File:

T0714056.D

Method:

EPA-8260

CAS Number	Name	Concentration(ug/L)	MDL (ug/L)
75-71-8	Dichlorodifluoromethane	ND	1.0
74-87-3	Chloromethane	ND	1.0
75-01-4	Chloroethene (Vinyl Chloride)	1.4	1.0
74-83-9	Bromomethane	ND	1.0
75-00-3	Chloroethane	ND	1.0
75-69-4	Trichlorofluoromethane	ND	1.0
75-35-4	1,1-Dichloroethene	ND	1.0
75-09-2	Dichloromethane	ND	1.0
01634-04-4	MTBE	ND	1.0
156-60-5	(E)-1,2-Dichloroethene	ND	1.0
75-34-3	1,1-Dichloroethane	ND	1.0
78-93-3	Methyl Ethyl Ketone (MEK)	ND	1.0
594-20-7	2,2-Dichloropropane	ND	1.0
156-59-2	(Z)-1,2-Dichloroethene	ND	1.0
74-97-5	Bromochloromethane	ND	1.0
67-66-3	Trichloromethane	ND	1.0
71-55-6	1,1,1-Trichloroethane	ND	1.0
563-58-6	1,1-Dichloropropene	ND	1.0
56-23-5	Tetrachloromethane	ND	1.0
71-43-2	Benzene	ND	1.0
107-06-2	1,2-Dichloroethane	ND	1.0
79-01-6	Trichloroethene	ND	1.0
78-87-5	1,2-Dichloropropane	ND	1.0
74-95-3	Dibromomethane	ND	1.0
75-27-4	Bromodichloromethane	ND	1.0
10061-01-5	(Z)-1,3-Dichloropropene	ND	1.0
108-10-1	MIBK	ND	1.0
108-88-3	Toluene	ND	1.0
10061-02-6	(E)-1,3-Dichloropropene	ND	1.0
79-00-5	1,1,2-Trichloroethane	ND	1.0
142-28-9	1,3-Dichloropropane	ND	1.0
127-18-4	Tetrachloroethene	ND	1.0
124-48-1	Dibromochloromethane	ND	1.0
106-93-4	1,2-Dibromoethane	ND	1.0
108-90-7	Chlorobenzene	ND	1.0
630-20-6	1,1,1,2-Tetrachloroethane	ND	1.0
100-41-4	Ethylbenzene	ND	1.0
108-38-3	m-Xylene + p-Xylene	ND	1.0
95-47-6	o-Xylene	ND	1.0
100-42-5	Styrene(ethyl-benzene)	ND	1.0
75-25-2	Bromoforn	ND	1.0
98-82-8	iso-Propylbenzene	ND	1.0
79-34-5	1,1,2,2-Tetrachloroethane	ND	1.0
96-18-4	1,2,3-Trichloropropane	ND	1.0
108-86-1	Bromobenzene	ND	1.0
103-65-1	n-Propylbenzene	ND	1.0
108-67-8	1,3,5-Trimethylbenzene	ND	1.0
106-43-4	4-Chlorotoluene	ND	1.0
95-49-8	2-Chlorotoluene	ND	1.0
98-06-9	tert-Butylbenzene	ND	1.0
95-63-6	1,2,4-Trimethylbenzene	ND	1.0
135-98-8	sec-Butylbenzene	ND	1.0
99-87-6	4-iso-Propyltoluene	ND	1.0
541-73-1	1,3-Dichlorobenzene	ND	1.0
106-46-7	1,4-Dichlorobenzene	ND	1.0
104-51-8	n-Butylbenzene	ND	1.0
95-50-1	1,2-Dichlorobenzene	ND	1.0
96-12-8	1,2-Dibromo-3-chloropropane	ND	1.0
120-82-1	1,2,4-Trichlorobenzene	ND	1.0
87-68-3	Hexachlorobutadiene	ND	1.0
91-20-3	Naphthalene	ND	1.0
87-61-6	1,2,3-Trichlorobenzene	ND	1.0
1868-33-7	Dibromofluoromethane(surr1)	41.1	102.7%
107-06-2	1,2-dichloroethane-d4(surr2)	40.6	101.6%
2037-26-5	toluene-d8(surr3)	40.3	100.8%
460-00-4	4-bromofluorobenzene(surr4)	30.2	75.4%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & X. WANG

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: Solutia-XDD

Sample Identification: 9907289, 90713-SB-111, 1/4000

Laboratory Identification: NA

Sampling Date: 7/13/99

Sample Receiving Date: 7/15/99

Date Analyzed: 07/16/19 -1:7:

Reporting Date: 7/17/99

Sample Matrix: Aqueous

Report Data File: SXDD990714W.XLS

Raw Data File: T0714066.D

Method: EPA-8260

CAS Number	Name	Concentration(ug/L)	MDL (ug/L)
75-71-8	Dichlorodifluoromethane	ND	4000.0
74-87-3	Chloromethane	ND	4000.0
75-01-4	Chloroethene(Vinyl Chloride)	932040.0	4000.0
74-83-9	Bromomethane	ND	4000.0
75-00-3	Chloroethane	ND	4000.0
75-69-4	Trichlorofluoromethane	ND	4000.0
75-35-4	1,1-Dichloroethene	ND	4000.0
75-09-2	Dichloromethane	ND	4000.0
01634-04-4	MTBE	ND	4000.0
156-60-5	(E)-1,2-Dichloroethene	ND	4000.0
75-34-3	1,1-Dichloroethane	ND	4000.0
78-93-3	Methyl Ethyl Ketone (MEK)	ND	4000.0
594-20-7	2,2-Dichloropropane	ND	4000.0
156-59-2	(Z)-1,2-Dichloroethene	120800.0	4000.0
74-97-5	Bromochloromethane	ND	4000.0
67-66-3	Trichloromethane	ND	4000.0
71-55-6	1,1,1-Trichloroethane	ND	4000.0
563-58-6	1,1-Dichloropropene	ND	4000.0
56-23-5	Tetrachloromethane	ND	4000.0
71-43-2	Benzene	ND	4000.0
107-06-2	1,2-Dichloroethane	ND	4000.0
79-01-6	Trichloroethene	ND	4000.0
78-87-5	1,2-Dichloropropane	ND	4000.0
74-95-3	Dibromomethane	ND	4000.0
75-27-4	Bromodichloromethane	ND	4000.0
10061-01-5	(Z)-1,3-Dichloropropene	ND	4000.0
108-10-1	MIBK	ND	4000.0
108-88-3	Toluene	ND	4000.0
10061-02-6	(E)-1,3-Dichloropropene	ND	4000.0
79-00-5	1,1,2-Trichloroethane	ND	4000.0
142-28-9	1,3-Dichloropropane	ND	4000.0
127-18-4	Tetrachloroethene	ND	4000.0
124-48-1	Dibromochloromethane	ND	4000.0
106-93-4	1,2-Dibromoethane	ND	4000.0
108-90-7	Chlorobenzene	ND	4000.0
630-20-6	1,1,1,2-Tetrachloroethane	ND	4000.0
100-41-4	Ethylbenzene	ND	4000.0
108-38-3	m-Xylene + p-Xylene	ND	4000.0
95-47-6	o-Xylene	ND	4000.0
100-42-5	Styrene(ethyl-benzene)	ND	4000.0
75-25-2	Bromoforn	ND	4000.0
98-82-8	iso-Propylbenzene	ND	4000.0
79-34-5	1,1,2,2-Tetrachloroethane	ND	4000.0
96-18-4	1,2,3-Trichloropropane	ND	4000.0
108-86-1	Bromobenzene	ND	4000.0
103-65-1	n-Propylbenzene	ND	4000.0
108-67-8	1,3,5-Trimethylbenzene	ND	4000.0
106-43-4	4-Chlorotoluene	ND	4000.0
95-49-8	2-Chlorotoluene	ND	4000.0
98-06-9	tert-Butylbenzene	ND	4000.0
95-63-6	1,2,4-Trimethylbenzene	ND	4000.0
135-98-8	sec-Butylbenzene	ND	4000.0
99-87-6	4-iso-Propyltoluene	ND	4000.0
541-73-1	1,3-Dichlorobenzene	ND	4000.0
106-46-7	1,4-Dichlorobenzene	ND	4000.0
104-51-8	n-Butylbenzene	ND	4000.0
95-50-1	1,2-Dichlorobenzene	ND	4000.0
96-12-8	1,2-Dibromo-3-chloropropane	ND	4000.0
120-82-1	1,2,4-Trichlorobenzene	ND	4000.0
87-68-3	Hexachlorobutadiene	ND	4000.0
91-20-3	Naphthalene	ND	4000.0
87-61-6	1,2,3-Trichlorobenzene	ND	4000.0
1868-33-7	Dibromofluoromethane(surr1)	40.1	100.2%
107-06-2	1,2-dichloroethane-d4(surr2)	40.7	101.9%
2037-26-5	toluene-d8(surr3)	41.1	102.8%
460-00-4	4-bromofluorobenzene(surr4)	31.0	77.4%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & X. WANG

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: Solutia-XDD

Sample Identification: 9907290, 90713-SB-112, 1/4000

Reporting Date: 7/17/99

Laboratory Identification: NA

Sample Matrix: Aqueous

Sampling Date: 7/13/99

Report Data File: SXDD990714W.XLS

Sample Receiving Date: 7/15/99

Raw Data File: T0714067.D

Date Analyzed: 07/16/19 -1:7:

Method: EPA-8260

CAS Number	Name	Concentration(ug/L)	MDL (ug/L)
75-71-8	Dichlorodifluoromethane	ND	4000.0
74-87-3	Chloromethane	ND	4000.0
75-01-4	Chloroethene(Vinyl Chloride)	494800.0	4000.0
74-83-9	Bromomethane	ND	4000.0
75-00-3	Chloroethane	ND	4000.0
75-69-4	Trichlorofluoromethane	ND	4000.0
75-35-4	1,1-Dichloroethene	ND	4000.0
75-09-2	Dichloromethane	ND	4000.0
01634-04-4	MTBE	ND	4000.0
156-60-5	(E)-1,2-Dichloroethene	ND	4000.0
75-34-3	1,1-Dichloroethane	ND	4000.0
78-93-3	Methyl Ethyl Ketone (MEK)	ND	4000.0
594-20-7	2,2-Dichloropropane	ND	4000.0
156-59-2	(Z)-1,2-Dichloroethene	106120.0	4000.0
74-97-5	Bromochloromethane	ND	4000.0
67-66-3	Trichloromethane	ND	4000.0
71-35-6	1,1,1-Trichloroethane	ND	4000.0
563-58-6	1,1-Dichloropropene	ND	4000.0
56-23-5	Tetrachloromethane	ND	4000.0
71-43-2	Benzene	ND	4000.0
107-06-2	1,2-Dichloroethane	32720.0	4000.0
79-01-6	Trichloroethene	4920.0	4000.0
78-87-5	1,2-Dichloropropane	ND	4000.0
74-95-3	Dibromomethane	ND	4000.0
75-27-4	Bromodichloromethane	ND	4000.0
10061-01-5	(Z)-1,3-Dichloropropene	ND	4000.0
108-10-1	MIBK	ND	4000.0
108-88-3	Toluene	ND	4000.0
10061-02-6	(E)-1,3-Dichloropropene	ND	4000.0
79-00-5	1,1,2-Trichloroethane	ND	4000.0
142-28-9	1,3-Dichloropropane	ND	4000.0
127-18-4	Tetrachloroethene	ND	4000.0
124-48-1	Dibromochloromethane	ND	4000.0
106-93-4	1,2-Dibromoethane	ND	4000.0
108-90-7	Chlorobenzene	ND	4000.0
630-20-6	1,1,1,2-Tetrachloroethane	ND	4000.0
100-41-4	Ethylbenzene	ND	4000.0
108-38-3	m-Xylene + p-Xylene	ND	4000.0
95-47-6	o-Xylene	ND	4000.0
100-42-5	Styrene(ethyl-benzene)	ND	4000.0
75-25-2	Bromoform	ND	4000.0
98-82-8	iso-Propylbenzene	ND	4000.0
79-34-5	1,1,2,2-Tetrachloroethane	ND	4000.0
96-18-4	1,2,3-Trichloropropane	ND	4000.0
108-86-1	Bromobenzene	ND	4000.0
103-65-1	n-Propylbenzene	ND	4000.0
108-67-8	1,3,5-Trimethylbenzene	ND	4000.0
106-43-4	4-Chlorotoluene	ND	4000.0
95-49-8	2-Chlorotoluene	ND	4000.0
98-06-9	tert-Butylbenzene	ND	4000.0
95-63-6	1,2,4-Trimethylbenzene	ND	4000.0
135-98-8	sec-Butylbenzene	ND	4000.0
99-87-6	4-iso-Propyltoluene	ND	4000.0
541-73-1	1,3-Dichlorobenzene	ND	4000.0
106-46-7	1,4-Dichlorobenzene	ND	4000.0
104-51-8	n-Butylbenzene	ND	4000.0
95-50-1	1,2-Dichlorobenzene	ND	4000.0
96-12-8	1,2-Dibromo-3-chloropropane	ND	4000.0
120-82-1	1,2,4-Trichlorobenzene	ND	4000.0
87-68-3	Hexachlorobutadiene	ND	4000.0
91-20-3	Naphthalene	ND	4000.0
87-61-6	1,2,3-Trichlorobenzene	ND	4000.0
1868-53-7	Dibromodifluoromethane(surr1)	41.6	104.0%
107-06-2	1,2-dichloroethane-d4(surr2)	41.1	102.7%
2037-26-5	toluene-d8(surr3)	43.9	109.7%
460-00-4	4-bromodifluorobenzene(surr4)	31.5	78.6%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

Analyzed by: J. KANG & X. WANG

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: Solutia-XDD

Sample Identification: 9907291, 90713-SB-113, 1/4000

Reporting Date: 7/17/99

Laboratory Identification: NA

Sample Matrix: Aqueous

Sampling Date: 7/13/99

Report Data File: SXDD990714W.XLS

Sample Receiving Date: 7/15/99

Raw Data File: T0714068.D

Date Analyzed: 07/16/19 -1:8:

Method: EPA-8260

CAS Number	Name	Concentration(ug/L)	MDL (ug/L)
75-71-8	Dichlorodifluoromethane	ND	4000.0
74-87-3	Chloromethane	ND	4000.0
75-01-4	Chloroethene(Vinyl Chloride)	746160.0	4000.0
74-83-9	Bromomethane	ND	4000.0
75-00-3	Chloroethane	ND	4000.0
75-69-4	Trichlorofluoromethane	ND	4000.0
75-35-4	1,1-Dichloroethene	ND	4000.0
75-09-2	Dichloromethane	ND	4000.0
01634-04-4	MTBE	ND	4000.0
156-60-5	(E)-1,2-Dichloroethene	ND	4000.0
75-34-3	1,1-Dichloroethane	ND	4000.0
78-93-3	Methyl Ethyl Ketone (MEK)	ND	4000.0
594-20-7	2,2-Dichloropropane	ND	4000.0
156-59-2	(Z)-1,2-Dichloroethene	101760.0	4000.0
74-97-5	Bromochloromethane	ND	4000.0
67-66-3	Trichloromethane	ND	4000.0
71-55-6	1,1,1-Trichloroethane	ND	4000.0
563-58-6	1,1-Dichloropropene	ND	4000.0
56-23-5	Tetrachloromethane	ND	4000.0
71-43-2	Benzene	ND	4000.0
107-06-2	1,2-Dichloroethane	ND	4000.0
79-01-6	Trichloroethene	21640.0	4000.0
78-87-5	1,2-Dichloropropane	ND	4000.0
74-95-3	Dibromomethane	ND	4000.0
75-27-4	Bromodichloromethane	ND	4000.0
10061-01-5	(Z)-1,3-Dichloropropene	ND	4000.0
108-10-1	MIBK	ND	4000.0
108-88-3	Toluene	ND	4000.0
10061-02-6	(E)-1,3-Dichloropropene	ND	4000.0
79-00-5	1,1,2-Trichloroethane	ND	4000.0
142-28-9	1,3-Dichloropropane	ND	4000.0
127-18-4	Tetrachloroethene	ND	4000.0
124-48-1	Dibromochloromethane	ND	4000.0
106-93-4	1,2-Dibromoethane	ND	4000.0
108-90-7	Chlorobenzene	ND	4000.0
630-20-6	1,1,1,2-Tetrachloroethane	ND	4000.0
100-41-4	Ethylbenzene	ND	4000.0
108-38-3	m-Xylene + p-Xylene	ND	4000.0
95-47-6	o-Xylene	ND	4000.0
100-42-5	Styrene(ethyl-benzene)	ND	4000.0
75-25-2	Bromoform	ND	4000.0
98-82-8	iso-Propylbenzene	ND	4000.0
79-34-5	1,1,2,2-Tetrachloroethane	ND	4000.0
96-18-4	1,2,3-Trichloropropane	ND	4000.0
108-86-1	Bromobenzene	ND	4000.0
103-65-1	n-Propylbenzene	ND	4000.0
108-67-8	1,3,5-Trimethylbenzene	ND	4000.0
106-43-4	4-Chlorotoluene	ND	4000.0
95-49-8	2-Chlorotoluene	ND	4000.0
98-06-9	tert-Butylbenzene	ND	4000.0
95-63-6	1,2,4-Trimethylbenzene	ND	4000.0
135-98-8	sec-Butylbenzene	ND	4000.0
99-87-6	4-iso-Propyltoluene	ND	4000.0
541-73-1	1,3-Dichlorobenzene	ND	4000.0
106-46-7	1,4-Dichlorobenzene	ND	4000.0
104-51-8	n-Butylbenzene	ND	4000.0
95-50-1	1,2-Dichlorobenzene	ND	4000.0
96-12-8	1,2-Dibromo-3-chloropropane	ND	4000.0
120-82-1	1,2,4-Trichlorobenzene	ND	4000.0
87-68-3	Hexachlorobutadiene	ND	4000.0
91-20-3	Naphthalene	ND	4000.0
87-61-6	1,2,3-Trichlorobenzene	ND	4000.0
1868-53-7	Dibromodifluoromethane(surr1)	40.3	100.8%
107-06-2	1,2-dichloroethane-d4(surr2)	40.9	102.3%
2037-26-5	toluene-d8(surr3)	40.8	102.0%
460-00-4	4-bromofluorobenzene(surr4)	31.4	78.4%

ND = Not Detected

Data Reviewed by: Dr. Shuli Liu, Laboratory Director

Analyzed by: J. KANG & X. WANG

**Environmental Research Institute
The University of Connecticut**

Volatile Organic Compound Results, Project: Solutia-XDD

Sample Identification: 9907292, 90713-SB-114, 1/4000

Reporting Date: 7/17/99

Laboratory Identification: NA

Sample Matrix: Aqueous

Sampling Date: 7/13/99

Report Data File: SXDD990714W.XLS

Sample Receiving Date: 7/15/99

Raw Data File: T0714069.D

Date Analyzed: 07/16/19 -1:9:

Method: EPA-8260

CAS Number	Name	Concentration(ug/L)	MDL (ug/L)
75-71-8	Dichlorodifluoromethane	ND	4000.0
74-87-3	Chloromethane	ND	4000.0
75-01-4	Chloroethene(Vinyl Chloride)	709560.0	4000.0
74-83-9	Bromomethane	ND	4000.0
75-00-3	Chloroethane	ND	4000.0
75-69-4	Trichlorofluoromethane	ND	4000.0
75-35-4	1,1-Dichloroethene	ND	4000.0
75-09-2	Dichloromethane	ND	4000.0
01634-04-4	MTBE	ND	4000.0
156-60-5	(E)-1,2-Dichloroethene	ND	4000.0
75-34-3	1,1-Dichloroethane	ND	4000.0
78-93-3	Methyl Ethyl Ketone (MEK)	ND	4000.0
594-20-7	2,2-Dichloropropane	ND	4000.0
156-59-2	(Z)-1,2-Dichloroethene	146720.0	4000.0
74-97-5	Bromochloromethane	ND	4000.0
67-66-3	Trichloromethane	ND	4000.0
71-55-6	1,1,1-Trichloroethane	ND	4000.0
563-58-6	1,1-Dichloropropene	ND	4000.0
56-23-5	Tetrachloromethane	ND	4000.0
71-43-2	Benzene	ND	4000.0
107-06-2	1,2-Dichloroethane	ND	4000.0
79-01-6	Trichloroethene	ND	4000.0
78-87-5	1,2-Dichloropropane	ND	4000.0
74-95-3	Dibromomethane	ND	4000.0
75-27-4	Bromodichloromethane	ND	4000.0
10061-01-5	(Z)-1,3-Dichloropropene	ND	4000.0
108-10-1	MIBK	ND	4000.0
108-88-3	Toluene	ND	4000.0
10061-02-6	(E)-1,3-Dichloropropene	ND	4000.0
79-00-5	1,1,2-Trichloroethane	ND	4000.0
142-28-9	1,3-Dichloropropane	ND	4000.0
127-18-4	Tetrachloroethene	ND	4000.0
124-48-1	Dibromochloromethane	ND	4000.0
106-93-4	1,2-Dibromoethane	ND	4000.0
108-90-7	Chlorobenzene	ND	4000.0
630-20-6	1,1,1,2-Tetrachloroethane	ND	4000.0
100-41-4	Ethylbenzene	ND	4000.0
108-38-3	m-Xylene + p-Xylene	ND	4000.0
95-47-6	o-Xylene	ND	4000.0
100-42-5	Styrene(ethyl-benzene)	ND	4000.0
75-25-2	Bromoform	ND	4000.0
98-82-8	iso-Propylbenzene	ND	4000.0
79-34-5	1,1,2,2-Tetrachloroethane	ND	4000.0
96-18-4	1,2,3-Trichloropropane	ND	4000.0
108-86-1	Bromobenzene	ND	4000.0
103-65-1	n-Propylbenzene	ND	4000.0
108-67-8	1,3,5-Trimethylbenzene	ND	4000.0
106-43-4	4-Chlorotoluene	ND	4000.0
95-49-8	2-Chlorotoluene	ND	4000.0
98-06-9	tert-Butylbenzene	ND	4000.0
95-63-6	1,2,4-Trimethylbenzene	ND	4000.0
135-98-8	sec-Butylbenzene	ND	4000.0
99-87-6	4-iso-Propyltoluene	ND	4000.0
541-73-1	1,3-Dichlorobenzene	ND	4000.0
106-46-7	1,4-Dichlorobenzene	ND	4000.0
104-51-8	n-Butylbenzene	ND	4000.0
95-50-1	1,2-Dichlorobenzene	ND	4000.0
96-12-8	1,2-Dibromo-3-chloropropane	ND	4000.0
120-82-1	1,2,4-Trichlorobenzene	ND	4000.0
87-68-3	Hexachlorobutadiene	ND	4000.0
91-20-3	Naphthalene	ND	4000.0
87-61-6	1,2,3-Trichlorobenzene	ND	4000.0
1868-33-7	Dibromofluoromethane(surr1)	41.4	103.5%
107-06-2	1,2-dichloroethane-d4(surr2)	42.6	106.5%
2037-26-5	toluene-d8(surr3)	40.2	100.4%
460-00-4	4-bromofluorobenzene(surr4)	31.2	78.1%

ND = Not Detected

Data Reviewed by: Dr. Shili Liu, Laboratory Director

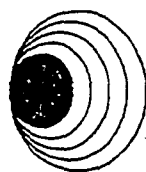
Analyzed by: J. KANG & X. WANG

APPENDIX C

Soil Boring Logs

Project: <u>BBL / SOLITA</u>	Project No: _____	Pg. <u>1</u> of <u>1</u>
Location: <u>SPRINGFIELD, MA</u>	Drilling Method: <u>DIRECT FLUSH</u>	Boring: <u>SB-111</u>
Drilling Co.: <u>BBL</u>	Rig Type: <u>AMS POWER PROBE 9600</u>	Date Started: <u>7/13/99</u>
Land Surf. Elev.: _____	Sample Device: <u>2" CORE SAMPLE / 1 1/2" LINER</u>	Date Completed: <u>7/13/99</u>
Meas. Pt. Elev.: _____	Logged by: <u>SCC</u>	

Depth (ft)	WELL COMPLETION	Blow Count	% Recovery ⁽¹²⁾	PID/FID (ppm)	Samples	Depth (ft)	Graphic Log	SOIL DESCRIPTION FROM CORE SAMPLE (INCHES OF CORE) DESCRIPTION.	USCS Symbol	% GR	% SA	% FI	Moisture
1								(5") ASPHALT					
2			23"	1				(5"-14") DARK BROWN FINE SAND AND TRACE FINE TO MED. GRAVEL					
3								(14"-23") LT. BROWN FINE SAND TRACE FINE GRAVEL					
4			23"	ND				(0-23") LT. BROWN FINE SAND / TRACE FINE GRAVEL					
5								(0-6") LT. BROWN FINE SAND / TRACE FINE GRAVEL / TRACE WHITE SPECS / MATERIAL?					
6			24"	3				(6"-23") SAME AS ABOVE / INCREASING FINE GRAVEL MOIST					
7								(23"-24") WHITE FINE MATERIAL					
8			24"					(0-10") WHITE FINE MATERIAL FINE AND WET					
								(10"-12") DARK BROWN FINE MATERIAL w/ WHITE TRACE MODIFIED (APPEARS OFF-WHITE)					
								(12"-24") DARK BROWN TO BROWN COARSE TO MEDIUM SAND WITH FINE TO MEDIUM GRAVEL WET					
								OK PID READING TAKEN FROM WHITE MATERIAL - (COMPOSITE w/ SOIL NOT TAKEN.)					



XDD, LLC

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Portsmouth, NH 03801
603-433-0191 fax 603-431-7807

SIEVE ANALYSES: CORES 0'-6" (Composite)
CORES 6'-10"-7'-8"

SOIL SAMPLE: bottle + MeOH = 1.6002 BOTTLE ①
+ SAMPLE = 2.3502

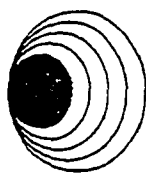
SAMPLED INTERVAL = 6-6.5"

Project: <u>BBL/SOLUTIA</u>	Project No: _____	Pg. <u>1</u> of <u>1</u>
Location: <u>SPRINGFIELD, MA</u>	Drilling Method: <u>DIRECT RUSH</u>	Boring: <u>SB 112</u>
Drilling Co.: <u>BBL</u>	Rig Type: <u>AMS POWERPORE 9000</u>	Date Started: <u>7/13/99</u>
Land Surf. Elev.: _____	Sample Device: <u>2" CORE SAMPLER / 1 1/2" LINER</u>	Date Completed: <u>7/13/99</u>
Meas. Pt. Elev.: _____	Logged by: <u>SCC</u>	

Depth (ft)	WELL COMPLETION	Blow Count	% Recovery (IN.)	PID/FID (ppm)	Samples	Depth (ft)	Graphic Log	SOIL DESCRIPTION (INCHES OF CORE) DESCRIPTION.	USCS Symbol	% GR	% SA	% FI	Moisture
1					X			(0-6") ASPHALT					
2			23"	3	X			(6"-23") LIGHT BROWN fine SAND trace fine Gravel					
3					X			(0-23") LIGHT BROWN fine SAND trace fine Gravel					
4			23"	ND	X								
5		denser ↓			X			(0-18") LIGHT BROWN fine SAND trace fine Gravel					
6			24"	9	X			(18"-24") white fine/very fine material Appears off-white in color					
7					X			(0-10") white/off-white material in dark brown matrix					
8			24"	67	X			(10"-13") brown brown medium sand fine gravel w/trace fines (grayish fines)					
								(13"-24") Brown to dark brown medium/coarse sand and fine gravel some pieces of brick WET below white material.					

1158
ppmv
IN white
material

PID READINGS TAKEN
FROM COMPLETE SAMPLES
OF SOIL CORES - white
material was screened
separately.



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SIEVE ANALYSIS:

4'9" → 5'6" CORE
5'6" → 6'0" WHITE material
6'0" → 6'9" CORE

SOIL SAMPLE:

bottle + mack = 1.5502

INTERVAL 5.5 → 6.0'

+SAMPLE = 2.3002

Project: <u>BBL/SOLUTIA</u>	Project No: _____	Pg. ____ of ____
Location: <u>SPRINGFIELD, MA</u>	Drilling Method: <u>DIRECT PUSH</u>	Borings <u>SB113</u>
Drilling Co.: <u>BBL</u>	Rig Type: <u>AMS POLAR PROBE</u>	Date Started: <u>7/13/99</u>
Land Surf. Elev.: _____	Sample Device: <u>2" GRS SAMPLER / 1 1/2" LINER</u>	Date Completed: <u>7/13/99</u>
Meas. Pt. Elev.: _____	Logged by: <u>SCC</u>	

Depth (ft)	WELL COMPLETION	Blow Count	% Recovery	PID/FID (ppm)	Samples	Depth (ft)	Graphic Log	SOIL DESCRIPTION (INCHES OF CORE) DESCRIPTION SAMPLE	USCS Symbol	% GR	% SA	% FI	Moisture
1					X			0-5" ASPHALT					
2			22"	2	X	2		5"-12" Dark brown fine Sand & Gravel 12"-24" Light brown fin Sand trace fine gravel					
3					X			0-23" SAME AS ABOVE					
4			23"	4	X	4		@ 23" OF CORE, fine white silty material, trace.					
5			Denser		X			0-19" SAME AS ABOVE					
6			24"	1	X	1		MOIST (NO white material) 19"-24" fine white material					1192 ppm n white material
7					X			0-19" DARK BROWN/BEAN medium to coarse Sand, fine gravel trace medium gravel trace cobbles, wet.					
8			19"	16	X								



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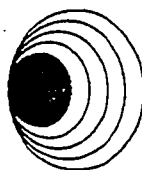
SIEVE ANALYSIS: 4'11" → 5'7" CORE
6'0" → 7'7" Composite CORE

SOIL SAMPLE: bottle + meOH = 1.5508
(5'7" - 6'0") interval w/sample = 2.5008

Project: <u>BBL / SULTIA</u>	Project No: _____	Pg. <u>1</u> of <u>1</u>
Location: <u>SPRINGFIELD, MA</u>	Drilling Method: <u>DIRECT PUSH</u>	Boring: <u>SB114</u>
Drilling Co.: <u>BBL</u>	Rig Type: <u>AMS POWER PRP 9000</u>	Date Started: <u>7/13/99</u>
Land Surf. Elev.: _____	Sample Device: <u>2" CORE SAMPLER / 1 1/2" LINER</u>	Date Completed: <u>7/13/99</u>
Meas. Pt. Elev.: _____	Logged by: <u>SCC</u>	

Depth (ft)	WELL COMPLETION	Blow Count	% Recovery	PID/FID (ppm)	Samples	Depth (ft)	Graphic Log	SOIL DESCRIPTION (INCHES of CORE Sample) Description.	USCS Symbol	% GR	% SA	% FI	Moisture
1								0-5") ASPHALT					
2			23"	ND				5"-13") dark brown fine sand & gravel 13"-24") Lt. brown fine sand trace fine gravel (Cobble @ 9"-12")					
3			24"					0-24") Lt. Brown fine sand trace fine gravel (moist from 12"-24")					
4			24"	3				0-11") Lt. Brown fine sand trace fine gravel w/ white material laminar @ 7-8"					
5			24"					11"-16") off white/brown fine material with trace fine sand					
6			24"	74				16"-24") off white fine material w/ trace fine/medium gravel dark brown laminar					
7								0-3") gray fine sand/trace fines/medium gravel					
8			24"	12				3"-8") brown medium sand and fine gravel trace cobbles 8"-14") Red brick 3- ~~fine~~ medium sand & gravel 14"-24") Brown medium/coarse sand w/ fine gravel and trace medium gravel some cobbles.					

(178 ppm)
in white
material



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SIEVE ANALYSES: 4'7" → 5'4" CORE
6'0" → 6'10" CORE

SOIL SAMPLE bottle + meOH = 1.550g
(INTERVAL 5.5-6.0') w/sample = 2.750g

APPENDIX D

Grain Size Analysis and Moisture Content Data

7/16/99

The concentrations of VOCs in Soil Samples from Solutia site.

Sample ID	VOCs, mg/kg*			
	Vinyl chloride	cis-1,2-Dichloroethene	1,2 Dichloroethane	Trichloroethene
SB 111 0'-6"	46.2	78.7		
SB 111	489	63.3	< 2.1	< 2.1
SB 112	272	58.4	18.0	2.71
SB 113	368	50.3	< 2.0	10.7
SB 114	300	62.1	< 1.7	< 1.7
Blank**	< 1.0	< 1.0	< 1.0	< 1.0

* wet basis

** results are expressed in µg/L.

Bottles sent with Chain of Custody Sheets to XDD on 7/8/99

Fri 7/7/95

Bottle #	Empty Wt g	Empty Wt + 25 mL MeOH, g	Wt of MeOH* g	Wt of MeOH + Bottle + Wet Soil, g	Wt of Wet Soil g
1	25.4864	45.2317	19.7453	67.4373	47.6920
2	25.2997	45.2235	19.9238	65.343	45.4192
3	25.4606	45.0203	19.5597	70.1847	50.6250
4	25.1803	44.7693	19.5890	78.6541	59.0651
5	Filled with DI water + 1 drop HCl (for Trip Blank)				

* Bottle # 1 through 4 filled with 25 mL of MeOH.

Density of MeOH = 0.788178

Moisture Content in Soil Samples From Solutia Site

Sample ID	Percent Moisture**, %
SB 111 0'-6"	10.8%
SB 111 6'10"- 7'8"	16.5%
SB 112 4'9"- 5'6"	13.2%
SB 112 5'6"- 6'0"	30.2%
SB 112 6'0"- 6'9"	7.2%
SB 113 4'11"- 5'7"	10.8%
SB 113 6'0"- 7'7"	12.3%
SB 114 4'7" - 5'4"	15.3%
SB 114 6'0" - 6'10"	9.8%

Note: Heating Overnight at 110 C

** expressed as percent of wet soil

Performed by Toni and Jon

7/15/99 - 7/16/99

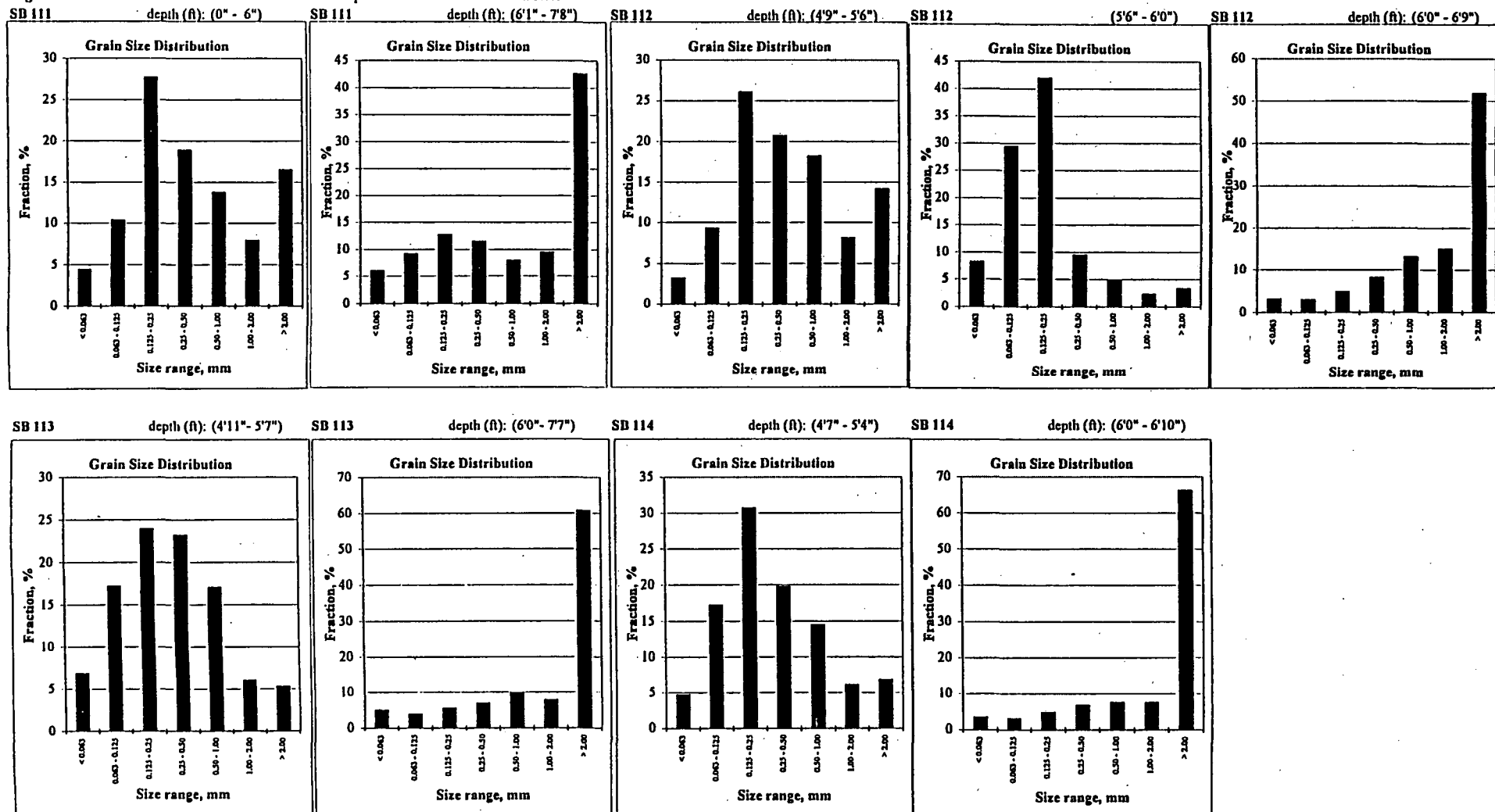
Raw Data for Determination of Moisture Content for Soil Samples - Solutia

Sample ID	Dish Wt g	Dish+ wet soil Wt, g	Tin + dry* soil Wt, g	Percent Moisture**, %
SB 111 0'-6"	46.1635	78.6960	75.1831	10.8%
SB 111 6'10"- 7'8"	45.7513	79.1104	73.6170	16.5%
SB 112 4'9"- 5'6"	75.0847	119.2626	113.4256	13.2%
SB 112 5'6"- 6'0"	73.0395	94.1522	87.7667	30.2%
SB 112 6'0"- 6'9"	77.8441	111.2430	108.8245	7.2%
SB 113 4'11"- 5'7"	46.6610	62.8131	61.0766	10.8%
SB 113 6'0"- 7'7"	46.6952	75.9909	72.3840	12.3%
SB 114 4'7"- 5'4"	46.8024	65.7900	62.8800	15.3%
SB 114 6'0"- 6'10"	75.2397	116.3942	112.3470	9.8%

* Heating Overnight at 110 C

** expressed as percent of wet soil

Figure 1 Grain size distribution for 9 soil samples obtained from Solutia site.



COMPOSITE GRAIN SIZE ANALYSIS OF SOIL FROM SOLUTIA, MASSACHUSETTS

Size, mm	Sieve #	% Fraction								
		SB 111 (0" - 6")	SB 111 (6'1" - 7'8")	SB 112 (4'9" - 5'6")	SB 112 (5'6" - 6'0")	SB 112 (6'0" - 6'9")	SB 113 (4'11" - 5'7")	SB 113 (6'0" - 7'7")	SB 114 (4'7" - 5'4")	SB 114 (6'0" - 6'10")
> 2.00	+10	16.56	42.72	14.23	3.39	52.02	5.34	60.88	6.85	66.42
1.00 - 2.00	+18	7.98	9.52	8.19	2.37	15.20	6.09	7.88	6.15	7.61
0.50 - 1.00	+35	13.82	8.09	18.25	4.92	13.29	17.10	9.92	14.46	7.61
0.25 - 0.50	+60	18.96	11.54	20.73	9.49	8.32	23.27	7.01	19.81	6.89
0.125 - 0.25	+120	27.81	12.77	26.11	42.03	4.96	24.02	5.52	30.76	4.74
0.063 - 0.125	+230	10.42	9.20	9.36	29.49	3.00	17.26	3.89	17.27	3.18
< 0.063	-230	4.45	6.15	3.14	8.31	3.21	6.92	4.90	4.70	3.55
	SUM:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Attachment 3

Typical Composition of Sodium Permanganate and Fact Sheets

**SODIUM PERMANGANATE****GRADE: 40 %****TYPICAL ANALYSIS****(Based on 20 Lot Composite from Oct. 95 to May 96)**Metals (mg/Kg):

Aluminum	1.20	Magnesium	1.00
Antimony	0.03	Mercury	0.06
Arsenic	0.25	Molybdenum	<1.00
Barium	1.10	Nickel	1.50
Beryllium	<1.00	Phosphorus	2.70
Bismuth	0.09	Potassium	1700.00
Boron	3.30	Selenium	0.06
Cadmium	0.21	Silicon	56.10
Calcium	5.80	Silver	<1.00
Chromium	11.40	Strontium	<1.00
Cobalt	2.90	Sulfur	351.00
Copper	1.00	Thallium	<1.00
Iron	5.20	Vanadium	<1.00
Lead	2.40	Zinc	1.00
Lithium	<1.00		

**SODIUM PERMANGANATE****GRADE: 40 %****TYPICAL ANALYSIS****(Based on 20 Lot Composite from Oct. 95 to May 96)**

<u>PARAMETER</u>	<u>SPECIFICATION</u>	<u>TYPICAL ANALYSIS</u>
% Assay	≥ 40	40.30
pH	5.5 - 7.0	6.84
Specific Gravity	1.36 - 1.39	1.3708
% Insolubles		0.025

LIQUOX™
Sodium Permanganate
CAS No. 10101-50-5

Fact Sheet

LIQUOX™ sodium permanganate is a liquid oxidant recommended for applications that require a concentrated permanganate solution.

Product Specifications

Assay	40% minimum as NaMnO ₄
pH	6.0 - 7.0
Specific Gravity	1.36 - 1.39
Solubility in Water	Miscible with water in all proportions.

Chemical/Physical Data

Formula	NaMnO ₄
Appearance	Dark Purple Solution
Insolubles	100 - 1900 ppm
Potassium	1000 - 2200 ppm
Stability	> 18 Months

Applications

- Printed Circuit Board Desmearing
- Pharmaceutical Synthesis Reactions
- Metal Cleaning Formulations
- Acid Mine Drainage
- Hydrogen Sulfide Odor Control
 - Remote Locations
 - Unheated Locations

Benefits

- Concentrated liquid oxidant is easily stored and handled. Feed equipment is simplified (no need to transfer and dissolve crystalline product).
- Dust problems associated with handling dry oxidants are eliminated.
- High solubility at room temperature. Reactions requiring a concentrated permanganate solution can be conducted without having to raise the temperature.
- Can be used instead of potassium permanganate whenever the potassium ion cannot be tolerated, or if dusting is a critical issue.

Shipping Containers

5 gallon (18.9L) Tight Head HDPE Jerrican

(UN Specification: 3H1) made of High Density Polyethylene (HDPE), weighs 3.5 lb (1.6 kg). Net weight is 57 lb (25.7 kg). Dimensions, 15.33 in. tall, 10.2 in. wide and 11.4 in. long (38.94 cm tall, 25.91 cm by 28.96 cm).

5 gallon (18.9L) Tight Head Steel Drum

(UN Specification: 1A1) made of 12 gauge, mild steel, weighs 5 lb (2.3 kg). Net weight is 57 lb (25.7 kg). The drum is 13.75 in. tall and 11.5 in. in diameter. (34.93 cm tall, 29.21 cm diameter)

55 gallon (208.2L) Closed Head Steel Drum

(UN Specification: 1A1) made of 16 gauge, mild steel, weighs 53.7 lb (24.4 kg). Net weight is 550 lb (249.5 kg). The drum is 34.6 in. tall, outside diameter 23.5 in., inside diameter 22.5 in. (87.9 cm tall, OD 59.7 cm, ID 57.2 cm).

Handling and Storage

Like any potent oxidant, LIQUOX™ sodium permanganate should be handled with care. Protective equipment during handling should include face shields and/or goggles, rubber or plastic gloves, rubber or plastic apron. If clothing becomes spotted, wash off immediately; spontaneous ignition can occur with cloth or paper. In cases where significant exposure exists, use of the appropriate NIOSH-MSHA dust or mist respirator or an air supplied respirator is advised.

The product should be stored in a cool, dry area in closed containers. Concrete floors are preferred. Avoid wooden decks. Spillage should be collected and disposed of properly. Contain and dilute spillage to approximately 6% with water and reduce with sodium thiosulfate, a bisulfite, or ferrous salt. The bisulfite or ferrous salt may require dilute sulfuric acid to promote reduction. Neutralize any acid used with sodium bicarbonate. Deposit sludge in an approved landfill or, where permitted, drain into sewer with large quantities of water.

As an oxidant, the product itself is non-combustible, but will accelerate the burning of combustible materials. Therefore, contact with all combustible materials and/or chemicals must be avoided. These include, but are not limited to: wood, cloth, organic chemicals, and charcoal. Avoid contact with acids, peroxides, sulfites, oxalates, and all other oxidizable inorganic chemicals. With hydrochloric acid, chlorine is liberated.

Shipping

LIQUOX™ sodium permanganate is classified as an oxidizer. Sodium permanganate is shipped domestically as Class 70 and has a Harmonized Code for export of 2841.69.0000.

Proper Shipping Name: Permanganates, Inorganic, Aqueous solution, n.o.s. (Contains Sodium Permanganate)

Hazard Class: 5.1

Identification Number: UN 3214

Packaging Group: II

Label Requirements: Oxidizer, 5.1

Special Provisions: T8-Intermodal transportation in IM 101 portable tanks

Package Requirement: 49 CFR Parts 171 to 180 Sections: 173.152, 173.202, 173.242

Quantity Limitations: 1 liter net for passenger aircraft or railcar. 5 liters net for cargo aircraft.

Vessel Stowage: D-material must be stowed "ondeck" on a cargo vessel, but is prohibited on a passenger vessel. Other provisions, stow "separated from" ammonium compounds, hydrogen peroxide, peroxides and superperoxides, cyanide compounds, and powdered metal.

Repackaging

When LIQUOX™ sodium permanganate is repackaged, the packaging, markings, labels, and shipping conditions must meet applicable federal regulations. See Code of Federal Regulations-49, Transportation, parts 171-180, and the Federal Hazardous Materials Transportation Act (HMTA).

Corrosive Properties

LIQUOX™ sodium permanganate is compatible with many metals and synthetic materials. Natural rubbers and fibers are often incompatible. Solution pH and temperature are also important factors. The material selected for use with sodium permanganate must also be compatible with any acid or alkali being used.

In neutral and alkaline solutions, sodium permanganate is **not corrosive** to carbon steel and 316 stainless steel. However, chloride corrosion of metals may be accelerated when an oxidant such as sodium permanganate is present in solution. Plastics such as teflon, polypropylene, HDPE and EDPM are also compatible with sodium permanganate.

Aluminum, zinc, copper, lead, and alloys containing these metals may be slightly affected by sodium permanganate solutions. Actual corrosion or compatibility studies should be made under the conditions in which the permanganate will be used prior to use.

Carus Value Added**LABORATORY SUPPORT**

Carus Chemical Company has technical assistance available to its potential and current customers to answer questions or perform laboratory and field testing including:

*Feasibility Studies

* Toxicity Evaluations

*Treatability Studies

*Analytical Services

*Field Trials

CARUS CHEMICAL COMPANY

During its more than 80-year history, Carus' ongoing reliance on research and development, as well as its emphasis on technical support and customer service, have enabled the company to become the world leader in permanganate, manganese, oxidation, and catalyst technologies.

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Attachment 4

MADEP Remedial Monitoring Transmittal Form

**MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION****Bureau of Waste Site Cleanup****REMEDIAL MONITORING
TRANSMITTAL FORM**

RELEASE TRACKING NUMBER

--	--

REPORTING MONTH/PERIOD/YEAR

--

A. INSTRUCTIONS

This form must be used to document the operation and monitoring of active remedial systems. One form must be completed for each system for each monitoring event required by the MCP pursuant to the performance standards specified in 40.0040 and 40.0800, and/or as required by DEP as a condition of approval of the remedial system(s). Completed and signed forms must be mailed to the appropriate DEP Regional Office, either as separate reports following a monitoring event, as part of an IRA/RA/URAM Status Report required for the site, and/or as otherwise specified by DEP in compliance with the MCP. Complete all that is applicable.

B. GENERAL INFORMATION

Town:	MCP action under which remediation conducted: ☐ IRA ☐ RAM ☐ Phase IV ☐ Phase V ☐ ROS ☐ Class C RAO
Address:	
Related RTN(s):	
PRP/Person conducting work:	
LSP:	Date of approval of written plan:
Contact person:	This submittal made as part of: ☐ Plan/Amended Plan ☐ Status Report ☐ Completion Report ☐ ROS ☐ Other
Phone:	
Dates of operation covered FROM: TO:	

C. TYPE(S) OF REMEDIAL SYSTEMS

Recovery/treatment systems (check all that apply): ☐ NAPL recovery ☐ Groundwater recovery ☐ Soil vapor extraction/bioventing ☐ Dual/Multi-Phase Extraction ☐ Application of Remedial Additives ☐ N ☐ P ☐ Peroxide ☐ ORC ☐ Other: ☐ Air stripping ☐ Vapor-phase carbon adsorption ☐ Aqueous-phase carbon adsorption ☐ Cat/Thermal oxidation ☐ Sparging/biosparging ☐ Other:	Effluent/Discharge (check all that apply): ☐ Sanitary Sewer/POTW ☐ Surface water (including storm drains) ☐ Upgradient groundwater re-infiltration ☐ Downgradient groundwater re-infiltration ☐ Vapor phase discharge to ambient air ☐ Other:
---	---

D. STATUS OF REMEDIAL SYSTEM(S) DURING REPORTING PERIOD - provide units of total volume or volume/time

☐ ACTIVE	☐ TEMPORARILY INACTIVE	☐ PERMANENTLY SHUT DOWN
➤ NAPL recovered: ➤ gw recovered/avg rate: ➤ gw discharged/avg rate: ➤ avg soil gas recovery rate: ➤ avg sparging rate: ➤ Remedial Additives date(s) applied: quantity applied:	➤ date system(s) shut down: ➤ projected date of start up: ➤ reason for shut down:	➤ date shut down: ☐ no further effluent discharges ☐ no further application of Remedial Additives planned; sufficient monitoring completed to demonstrate compliance with 310 CMR 40.0046 ☐ other:
		☐ No further submittals will be made
Number of days treatment system(s) was FULLY functional during this reporting period:		

E. MONITORING - Indicate the frequency of monitoring for the reporting period (number/time)

MECHANICAL SYSTEMS	EFFLUENT/DISCHARGE	SITE
➤ Remote (modem) checks:	➤ Volumetric measurement:	➤ Key gw wells:
➤ On-site inspections:	➤ Testing of effluent quality:	➤ Key vapor wells:

Attachment 5

Utility Locating Standard Operating Procedures

Attachment 5

Utilities Locating Standard Operating Procedures

I. Introduction

Utilities must be located and clearances established prior to initiating investigations. Utilities are either buried and/or aboveground. Typically, natural gas, telephone, cable television, power, water, and sewer lines, as well as industry-specific utilities such as piping and electrical conduits are buried. Overhead utilities can consist of power lines, piping, and various conveyor set-ups. For safety, as well as ensuring continued operations, it is imperative that buried utilities be located and that ground clearance for overhead utilities be identified. Work delays which translate into increased costs can be expected should these utilities be damaged.

II. Materials

Utility locating is required where subsurface investigations are conducted. To this end, BBL would provide a site plan showing the proposed locations of boreholes, testpits, or trenches. The following list identifies the material required to expedite utility locating:

- “As built” drawings showing utilities of known existing municipal and private utilities to be provided by property owner/operator; and
- Site plan showing proposed subsurface investigation locations with estimated depths/lateral extent of excavations/boreholes/trenches will be provided by BBL.

III. Procedure

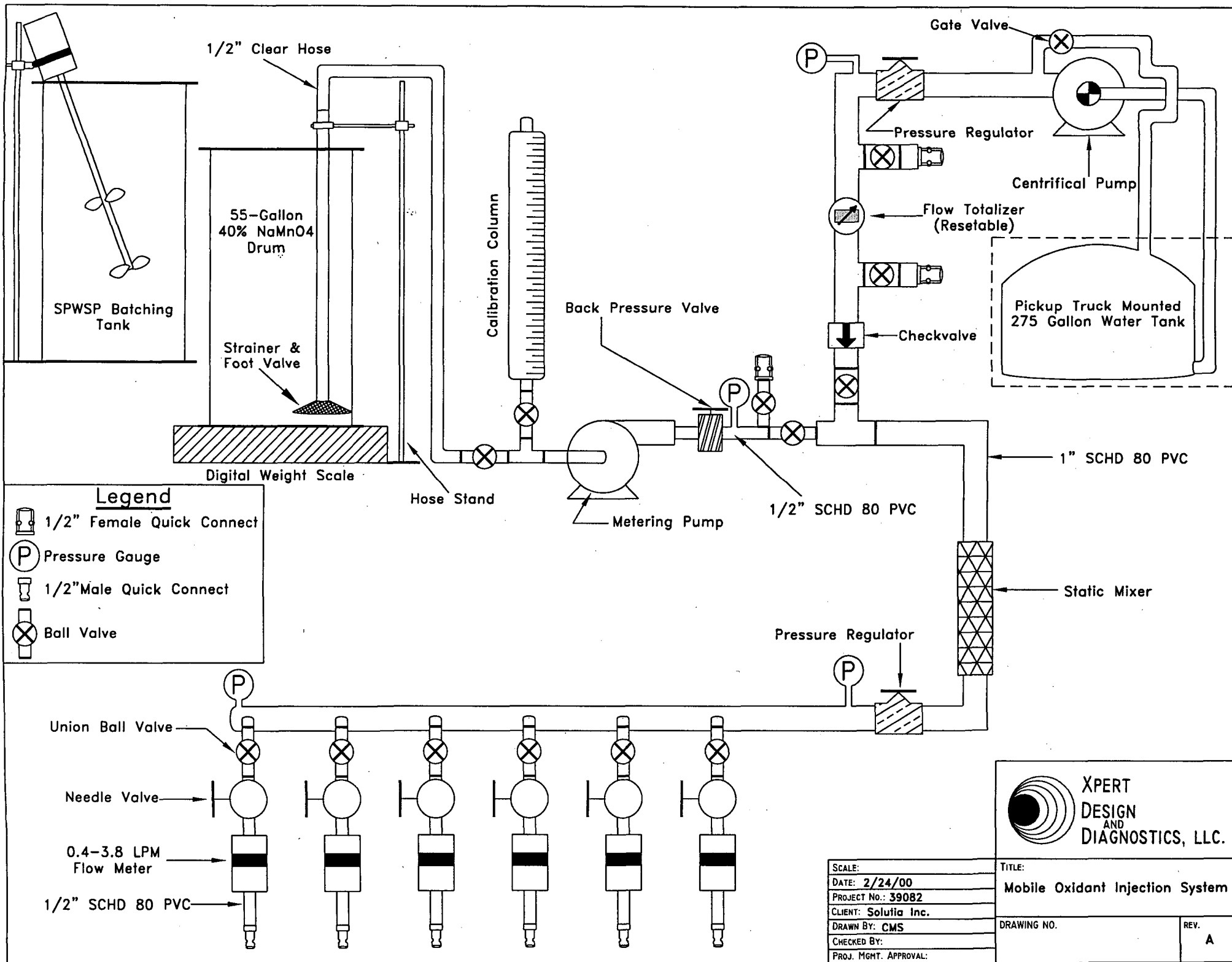
The following steps are provided as a guideline to completing utility clearance as quickly as possible¹:

1. BBL will review “as built” drawings provided by property owner/operator showing aboveground/buried services;

2. BBL will contact the underground services locator, including municipalities, to identify and physically mark out known buried services in the area, at least 72 hours prior to scheduled start date, and record the confirmation number along with the date;
3. BBL will provide the underground utility locator, such as "Dig Safe," a site plan with proposed borehole/testpit/trench locations;
4. BBL will contact the on-site owner/operator to identify owner installed underground services;
5. Where possible, BBL will attend site when utility locating is being conducted to become familiar with possible restrictions during mark out of known underground utilities; however, should it not be possible for BBL to attend the site, the on-site owner/operator will attend;
6. Should it be necessary, BBL will modify proposed locations based on completion of the above steps; and
7. The property owner/operator will review locations and utility mark outs and provide a final authorization to dig, excavate, or drill on an underground utility clearance form.

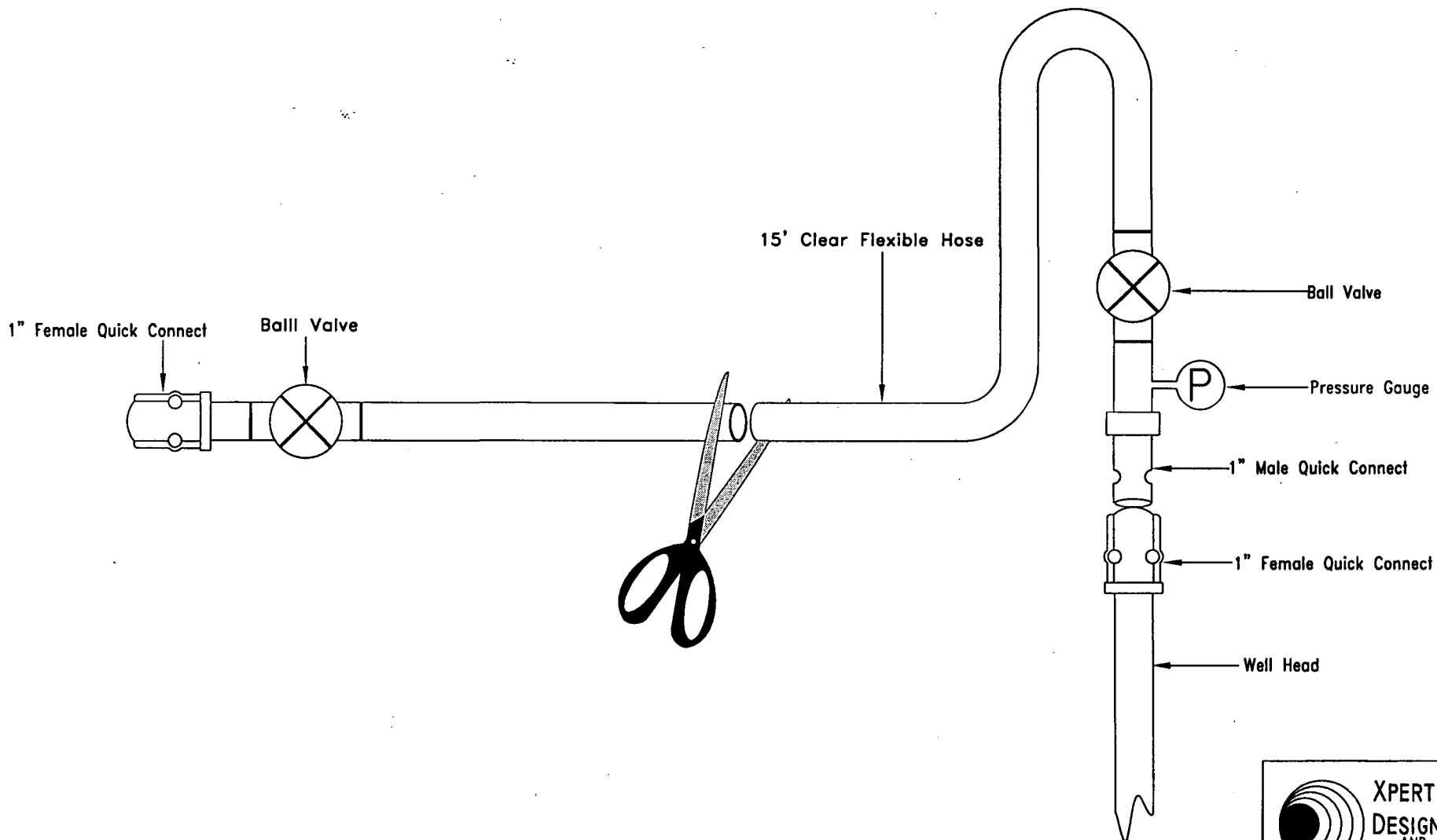
Attachment 6

Schematic of the PCOIS



**XPert
DESIGN
AND
DIAGNOSTICS, LLC.**

SCALE: _____ DATE: 2/24/00 PROJECT NO.: 39082 CLIENT: Solutia Inc. DRAWN BY: CMS CHECKED BY: _____ PROJ. MGMT. APPROVAL: _____		TITLE: Mobile Oxidant Injection System	
DRAWING NO. _____		REV. A	



SCALE:
DATE: 2/24/00
PROJECT No.: 39082
CLIENT: Solutia Inc.
DRAWN BY: CMS
CHECKED BY:
PROJ. MGMT. APPROVAL:

TITLE: Typical Hose Section	
DRAWING NO.	REV. A

Attachment 7

**USEPA Region I Low Stress (Low
Flow) Purging and Sampling
Procedures for the Collection of
Ground-Water Samples from
Monitoring Wells, July 30, 1996.
Revision 2.**

AUG 26 1998

**U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I**

**LOW STRESS (low flow) PURGING AND SAMPLING
PROCEDURE FOR THE COLLECTION OF
GROUND WATER SAMPLES
FROM MONITORING
WELLS**



**July 30, 1996
Revision 2**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
J.F.K. FEDERAL BUILDING
BOSTON, MASSACHUSETTS 02203

MEMORANDUM

DATE: September 23, 1996

SUBJ: New Procedure for Collecting Ground Water Samples for
the Determination of Organic and Inorganic Analytes

FROM: Linda M. Murphy, Director *Linda Murphy*
Office of Site Remediation and Restoration

Edward J. Conley, Director *E. Conley*
Office of Environmental Measurement and Evaluation

TO: OSRR, OEME
David Fierra, Director
Office of Ecosystem Protection

The purpose of this memorandum is to issue the new EPA-New England guidelines for the collection of ground-water samples from monitoring wells. The attached standard operating procedure (SOP) is one of several products being developed jointly by OSRR and OEME as part of the Superfund Reforms and Innovative Technology Initiative. This SOP has been peer reviewed by individuals from the Superfund and RCRA Ground Water Forum, Superfund and RCRA Headquarters staff, R.S. Kerr Environmental Research Center, and private contractors.

The impetus for low stress (low flow) sampling was initially related to the need to collect unfiltered metals samples for determination of potential risks to human health. Conventional sampling methods often overestimate metals concentrations due to artificially elevated turbidity levels. However, filtering the water sample may cause the total contaminant loads, and therefore potential risks, to be underestimated. More recent technical literature and regional sampling experience indicate that the benefits of utilizing the low stress technique extends to sampling all inorganic and organic analyses. The major benefit is that the water quality data will be more reproducible and representative of actual ground-water conditions. Reasons for this include:

- o purging and sampling operations are more controlled,
- o pumping stresses are minimized,
- o objective criteria are used to determine when sampling should begin,

o operational variability between sampling events can be minimized.

This standard operating procedure should be integrated into ground-water sampling programs at Superfund, Federal Facility, and RCRA sites. It is also strongly recommended for all EPA New England programs that collect or use water quality data from monitoring wells.

Richard Willey, OSRR (617-573-9639) and Charles Porfert, OEME (617-860-4313) took the lead in developing these procedures. Please contact them should you need assistance in implementation of the procedures or information on the selection of field equipment.

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE
FOR THE COLLECTION OF GROUND WATER SAMPLES
FROM MONITORING WELLS

I. SCOPE & APPLICATION

This standard operating procedure (SOP) provides a general framework for collecting ground water samples that are indicative of mobile organic and inorganic loads at ambient flow conditions (both the dissolved fraction and the fraction associated with mobile particulates). The SOP emphasizes the need to minimize stress by low water-level drawdowns, and low pumping rates (usually less than 1 liter/min) in order to collect samples with minimal alterations to water chemistry. This SOP is aimed primarily at sampling monitoring wells that can accept a submersible pump and have a screen, or open interval length of 10 feet or less (this is the most common situation). However, this procedure is flexible and can be used in a variety of well construction and ground-water yield situations. Samples thus obtained are suitable for analyses of ground water contaminants (volatile and semi-volatile organic analytes, pesticides, PCBs, metals and other inorganics), or other naturally occurring analytes.

This procedure does not address the collection of samples from wells containing light or dense non-aqueous phase liquids (LNAPLs and DNAPLs). For this the reader may wish to check: Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation; C.K. Smoley (CRC Press), Boca Raton, Florida and U.S. Environmental Protection Agency, 1992, RCRA Ground-Water Monitoring: Draft Technical Guidance; Washington, DC (EPA/530-R-93-001).

The screen, or open interval of the monitoring well should be optimally located (both laterally and vertically) to intercept existing contaminant plume(s) or along flowpaths of potential contaminant releases. It is presumed that the analytes of interest move (or potentially move) primarily through the more permeable zones within the screen, or open interval.

Use of trademark names does not imply endorsement by U.S.EPA but is intended only to assist in identification of a specific type of device.

Proper well construction and development cannot be overemphasized, since the use of installation techniques that are appropriate to the hydrogeologic setting often prevents "problem well" situations from occurring. It is also recommended that as part of development or redevelopment the well should be tested to determine the appropriate pumping rate to obtain stabilization of field indicator parameters with minimal drawdown in shortest amount of time. With this information field crews can then conduct purging and sampling in a more expeditious manner.

The mid-point of the saturated screen length (which should not exceed 10 feet) is used by convention as the location of the pump intake. However, significant chemical or permeability contrast(s) within the screen may require additional field work to determine the optimum vertical location(s) for the intake, and appropriate pumping rate(s) for purging and sampling more localized target zone(s). Primary flow zones (high(er) permeability and/or high(er) chemical concentrations) should be identified in wells with screen lengths longer than 10 feet, or in wells with open boreholes in bedrock. Targeting these zones for water sampling will help insure that the low stress procedure will not underestimate contaminant concentrations. The Sampling and Analysis Plan must provide clear instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the remaining criteria in this procedure are met. If after 4 hours of purging indicator field parameters have not stabilized, one of 3 optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization) c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may not meet the sampling objectives).

Changes to this SOP should be proposed and discussed when the site Sampling and Analysis Plan is submitted for approval. Subsequent requests for modifications of an approved plan must include adequate technical justification for proposed changes. All changes and modifications must be approved before implementation in field.

II. EQUIPMENT

A. Extraction device

Adjustable rate, submersible pumps are preferred (for example, centrifugal or bladder pump constructed of stainless steel or Teflon).

Adjustable rate, peristaltic pumps (suction) may be used with caution. Note that EPA guidance states: "Suction pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" (EPA/540/P-87/001, 1987, page 8.5-11).

The use of inertial pumps is discouraged. These devices frequently cause greater disturbance during purging and sampling and are less easily controlled than the pumps listed above. This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

B. Tubing

Teflon or Teflon lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for inorganics analyses. However, these materials should be used with caution when sampling for organics. If these materials are used, the equipment blank (which includes the tubing) data must show that these materials do not add contaminants to the sample.

Stainless steel tubing may be used when sampling for VOCs, SVOCs, pesticides, and PCBs. However, it should be used with caution when sampling for metals.

The use of 1/4 inch or 3/8 inch (inner diameter) tubing is preferred. This will help ensure the tubing remains liquid filled when operating at very low pumping rates.

Pharmaceutical grade (Pharmed) tubing should be used for the section around the rotor head of a peristaltic pump, to minimize gaseous diffusion.

C. Water level measuring device(s), capable of measuring to 0.01 foot accuracy (electronic "tape", pressure transducer). Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use

must include check measurements with a water level "tape" at the start and end of each record.

D. Flow measurement supplies (e.g., graduated cylinder and stop watch).

E. Interface probe, if needed.

F. Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate the samples.

G. Indicator field parameter monitoring instruments - pH, Eh, dissolved oxygen (DO), turbidity, specific conductance, and temperature. Use of a flow-through-cell is required when measuring all listed parameters, except turbidity. Standards to perform field calibration of instruments. Analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846. For Eh measurements, follow manufacturer's instructions.

H. Decontamination supplies (for example, non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.).

I. Logbook(s), and other forms (for example, well purging forms).

J. Sample Bottles.

K. Sample preservation supplies (as required by the analytical methods).

L. Sample tags or labels.

M. Well construction data, location map, field data from last sampling event.

N. Well keys.

O. Site specific Sample and Analysis Plan/Quality Assurance Project Plan.

P. PID or FID instrument (if appropriate) to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

III. PRELIMINARY SITE ACTIVITIES

Check well for security damage or evidence of tampering, record pertinent observations.

Lay out sheet of clean polyethylene for monitoring and sampling equipment.

Remove well cap and immediately measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field logbook.

If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook.

A synoptic water level measurement round should be performed (in the shortest possible time) before any purging and sampling activities begin. It is recommended that water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) be measured the day before, in order to allow for re-settlement of any particulates in the water column. If measurement of total well depth is not made the day before, it should not be measured until after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe are usually not needed unless analytical data or field head space information signal a worsening situation. Note: procedures for collection of LNAPL and DNAPL samples are not addressed in this SOP.

IV. PURGING AND SAMPLING PROCEDURE

Sampling wells in order of increasing chemical concentrations (known or anticipated) is preferred.

1. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the midpoint of the zone to be sampled. The Sampling and Analysis Plan should specify the sampling depth, or provide criteria for selection of intake depth for each well (see Section I). If possible keep the pump intake at least two

feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well. Collection of turbid free water samples may be especially difficult if there is two feet or less of standing water in the well.

2. Measure Water Level

Before starting pump, measure water level. If recording pressure transducer is used-initialize starting condition.

3. Purge Well

3a. Initial Low Stress Sampling Event

Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check water level. Adjust pump speed until there is little or no water level drawdown (less than 0.3 feet). If the minimal drawdown that can be achieved exceeds 0.3 feet but remains stable, continue purging until indicator field parameters stabilize.

Monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (for example, 0.1 - 0.4 l/min) to ensure stabilization of indicator parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. Do not allow the water level to fall to the intake level (if the static water level is above the well screen, avoid lowering the water level into the screen). The final purge volume must be greater than the stabilized drawdown volume plus the extraction tubing volume.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (bladder, peristaltic), and/or the use of dedicated equipment. If the recharge rate of the well is lower than extraction rate capabilities of currently manufactured pumps and the well is essentially dewatered during purging, then the well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples (ideally the intake should not be moved during this recovery period). Samples may then be collected even though the indicator field parameters have not stabilized.

3b. Subsequent Low Stress Sampling Events

After synoptic water level measurement round, check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). Perform purging operations as above.

4. Monitor Indicator Field Parameters

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, Eh, DO) every three to five minutes (or less frequently, if appropriate). Note: during the early phase of purging emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at three (3) to five (5) minute intervals, are within the following limits:

- turbidity (10% for values greater than 1 NTU),
- DO (10%),
- specific conductance (3%),
- temperature (3%),
- pH (± 0.1 unit),
- ORP/Eh (± 10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell and may also cause an underestimation of turbidity values measured after the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities.

The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must be submerged in water at all times. If two flow-through-cells are used in series, the one containing the dissolved oxygen probe should come first (this parameter is most susceptible to error if air leaks into the system).

5. Collect Water Samples

Water samples for laboratory analyses must be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain sample).

VOC samples should be collected first and directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

During purging and sampling, the tubing should remain filled with water so as to minimize possible changes in water chemistry upon contact with the atmosphere. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use one of the following procedures to collect samples: (1) add clamp, connector (Teflon or stainless steel) or valve to constrict sampling end of tubing; (2) insert small diameter Teflon tubing into water filled portion of pump tubing allowing the end to protrude beyond the end of the pump tubing; collect sample from small diameter tubing; (3) collect non-VOC samples first, then increase flow rate slightly until the water completely fills the tubing, collect sample and record new drawdown, flow rate and new indicator field parameter values.

Add preservative, as required by analytical methods, to samples immediately after they are collected if the sample containers are not pre-preserved. Check analytical methods (e.g. EPA SW-846, water supply, etc.) for additional information on preservation. Check pH for all samples requiring pH adjustment to assure proper pH value. For VOC samples, this will require that a test sample be collected during purging to determine the amount of preservative that needs to be added to the sample containers prior to sampling.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter is required, and the filter size (0.45 um is commonly used) should be based on the sampling objective. Pre-rinse the filter with approximately 25 - 50 ml of ground water prior to sample collection. Preserve filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in ground water for human health risk calculations..

Label each sample as collected. Samples requiring cooling (volatile organics, cyanide, etc.) will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

6. Post Sampling Activities

If recording pressure transducer is used, remeasure water level with tape.

After collection of the samples, the pump tubing may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth is optional after the initial low stress sampling event. However, it is recommended if the well has a "silting" problem or if confirmation of well identity is needed.

Secure the well.

V. DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well and following sampling of each subsequent well. Pumps will not be removed between purging and sampling operations. The pump and tubing (including support cable and electrical wires which are in contact with the well) will be decontaminated by one of the procedures listed below.

Procedure 1

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is

recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Flush with isopropyl alcohol (pesticide grade). If equipment blank data from the previous sampling event show that the level of contaminants is insignificant, then this step may be skipped.

Flush with distilled/deionized water. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

VI.FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the ground water samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples shall be collected for each batch of samples (a batch

may not exceed 20 samples). Trip blanks are required for the VOC samples at a frequency of one set per VOC sample cooler.

Field duplicate.

Matrix spike.

Matrix spike duplicate.

Equipment blank.

Trip blank (VOCs).

Temperature blank (one per sample cooler).

Equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank will only include the pump in subsequent sampling rounds.

Collect samples in order from wells with lowest contaminant concentration to highest concentration. Collect equipment blanks after sampling from contaminated wells and not after background wells.

Field duplicates are collected to determine precision of sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

If split samples are to be collected, collect split for each analyte group in consecutive order (VOC original, VOC split, etc.). Split sample should be as identical as possible to original sample.

All monitoring instrumentation shall be operated in accordance with EPA analytical methods and manufacturer's operating instructions. EPA analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846 with exception of Eh, for which the manufacturer's instructions are to be followed. Instruments shall be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be re-calibrated so that all measurements fall within the calibration range. At the end of each day, check calibration to verify that instruments remained in calibration. Temperature measuring equipment, thermometers and thermistors, need not be calibrated to the above frequency. They should be checked for accuracy prior to field use according to EPA Methods and the manufacturer's instructions.

VII. FIELD LOGBOOK

A field log shall be kept to document all ground water field monitoring activities (see attached example matrix), and record all of the following:

Well identification.

Well depth, and measurement technique.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, and clock time, at the appropriate time intervals; calculated or measured total volume pumped.

Well sampling sequence and time of each sample collection.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analysis.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling equipment used, including trade names, model number, diameters, material composition, etc.

VIII. DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, and whatever field logbook information is needed to allow for a full evaluation of data useability.

EXAMPLE (Minimum Requirements)
Well PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Page ____ of ____

Location (Site/Facility Name) _____	Depth to _____ / _____ of screen
Well Number _____ Date _____	(below MP) top bottom
Field Personnel _____	Pump Intake at (ft. below MP) _____
Sampling Organization _____	Purging Device; (pump type) _____
Identify MP _____	

Clock Time	Water Depth below MP	Pump Dial ¹	Purge Rate	Cum. Volume Purged	Temp.	Spec. Cond. ²	pH	ORP/Eh ³	DO	Turbidity	Comments
24 HR	ft		ml/min	liters	°C	μS/cm		mv	mg/L	NTU	

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. μSiemens per cm (same as μmhos/cm) at 25°C.
3. Oxidation reduction potential (stand in for Eh).

Attachment 8

Specific Capacity Test Procedure

Attachment 8

Specific Capacity Test Procedures

I. Introduction

Specific capacity testing is a field method used to estimate the transmissivity of a saturated geologic medium surrounding the screened or open interval of a well. A specific capacity test involves pumping ground water from a well at a constant rate and quantifying the pumping rate and the magnitude of drawdown inside of the tested well after a known duration of pumping. Specific capacity tests are also referred to as single well pumping tests or constant rate tests.

The transmissivity is calculated based on the observed test pumping rates, the drawdown measured immediately before the end of pumping, the pumping duration that preceded the drawdown measurement, the effective radius of the well, and the estimated storativity of the formation. If the thickness of the effective water bearing zone transmitting ground-water to the well intake is assumed to be approximately equal to the length of the intake, the hydraulic conductivity can be estimated by dividing the transmissivity by the length of the intake.

II. Materials

The equipment needed for specific capacity testing includes:

- a pump (preferably submersible) capable of pumping at a controlled rate between a fraction of one gallon per minute and 10 gallons per minute, equipped with discharge line;
- a power source for the pump;
- a calibrated in-line totalizing flow meter or two calibrated buckets;
- a stopwatch; and
- an electronic water-level indicator.

III. Pre-Test Set-Up

Prior to the installation of the pump into the well to be tested, the static water level inside the well is measured to the nearest 0.01 feet relative to a specified datum at the top of the well using the electronic water-level indicator.

The water level and the time of the measurement are recorded in the field notebook. The water level is measured again several minutes after the initial measurement. This measurement and time are recorded. This procedure is repeated until two consecutive measurements are identical, indicating approximately static conditions. The static depth to water is recorded.

The pump is installed into the well to approximately 10 feet below the static water level, or within approximately 1 foot of the bottom of the well if the initial water column in the well is less than 11 feet. After the pump is installed but prior to pumping, the water level in the well is monitored until it has returned to within 0.01 feet of the static water level.

VI. Test Procedures

The specific capacity test is performed as follows:

1. Hold the water level probe in the well just above the static water level. If an in-line totalizing flow meter is used, record the pre-test volume measurement in the field notebook. If no in-line flow meter is available, place the end on the discharge line in one of the two calibrated buckets. Record the total volumetric capacity of each bucket.
2. Simultaneously start the pump and the stopwatch. Record the start time.
3. Immediately begin monitoring the water level in the well. If the drawdown rapidly approaches or passes 3 feet, quickly reduce the pumping rate until the drawdown is approximately 0.5 to 1.0 feet. All pumping rate adjustments should be completed within one or two minutes of pumping, after which no adjustment should be made other than minor adjustments that may be necessary to maintain a steady pumping rate.
4. Continue to pump for at least 20 minutes, recording the water-level in the well approximately every 2 minutes throughout the test. If an in-line flow meter is used, record the volume measurement on the totalizer gauge approximately every 2 minutes during the test. If calibrated buckets are used to measure the pumping rate, record the time at which the bucket reaches is known, recorded volumetric capacity, and the volume of the

bucket. Transfer the discharge line to the other (empty) calibrated bucket and record the time when it becomes full. Repeat this procedure for the duration of the test.

5. The specific capacity test is complete after at least 20 minutes of pumping have elapsed. A longer pumping period is not necessary to estimate transmissivity from the test. However, if practicable, a longer test may provide a slightly more reliable transmissivity estimate. Immediately before the termination of pumping, record final water level measurement plus the time of the measurement.
6. Calculate and record the total volume of ground water removed from the well during the test, and the total duration of the test. Divide the total volume (in gallons) by the total pumping duration (in minutes) to calculate and record the average test pumping rate (in gallons per minute).

V. Specific Capacity Test Data Reduction

Data from a specific capacity test are reduced to a transmissivity estimate for water-bearing formation surrounding the intake of the tested well by entering them into a specific capacity test data reduction spreadsheet program (QSTRANS) developed at Blasland, Bouck & Lee, Inc. QSTRANS iteratively solves for the value of transmissivity in the equation (Walton 1962):

$$Q/s = T / [264 \log(Tt/2693r_w^2S) - 65.5],$$

where Q/s is the specific capacity of the well in gallons per minute per foot, Q is the average test pumping rate in gallons per minute, s is the drawdown measured inside of the tested well after a known duration of pumping (t), T is the transmissivity of the water-bearing zone surrounding the intake of the tested well, S is the estimated storativity of the aquifer, r_w is the effective radius of the well, and t is the time in minutes between the start of pumping and the time when the drawdown was measured. If the well screen is surrounded by a sand pack that may be assumed to be substantially more permeable than the formation, the effective radius of the well is taken to be that of the borehole.

The value of S may be estimated without introducing serious error into the results. For confined aquifers, S should be estimated as 0.0001. For unconfined aquifers, the short-term storativity may be comparable to that of a confined aquifer. Only after a protracted pumping duration (several hours or more) does the storativity begin to approximately the aquifer specific yield of approximately 0.2 to 0.3 (Nwankwor et al., 1984). In the calculation

of transmissivity from a specific capacity test of less than one hour duration, therefore, an estimated storativity value of 0.01 should be entered into QSTRANS.

To obtain an estimate of the hydraulic conductivity of the water-bearing zone that transmits ground-water to the well, the calculated transmissivity value may be divided by the estimated thickness of the water-bearing zone. In a stratified formation in which the horizontal hydraulic conductivity may be expected to greatly exceed the vertical hydraulic conductivity, the thickness of the water-bearing zone may be estimated as the length of the well intake to obtain an estimate of the hydraulic conductivity immediately surrounding the well intake.

References

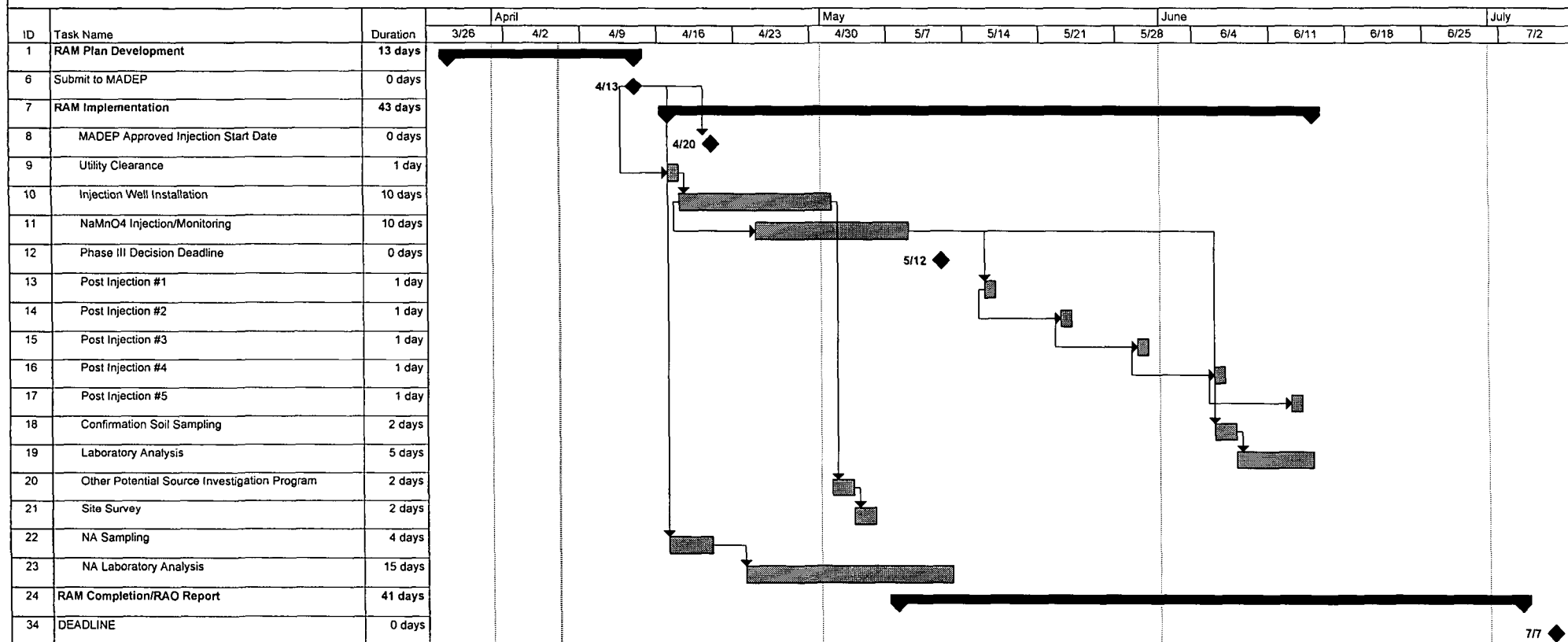
- Nwankwor, G.I., Cherry, J.A., and R.W. Gillham, 1985, A comparative study of specific yield determinations for a shallow sand aquifer, *Ground Water*, Vol. 22, No. 6, pp. 764-772.
- Walton, W.C., 1962, *Selected Analytical Methods for Well and Aquifer Evaluation*, Illinois State Water Survey Bulletin 19.

Attachment 9

RAM Plan Schedule

Former Gas Holder Area RAM Schedule

DRAFT



Assumes an installation rate of seven injection wells per day.
Assumes Chem-Ox injection will begin five working days after the start of injection well installations, even if all injection wells have not been installed.

Task		Milestone		Rolled Up Split		External Tasks	
Split		Summary		Rolled Up Milestone		Project Summary	
Progress		Rolled Up Task		Rolled Up Progress			

Attachment 10

MADEP RAM Transmittal Forms



RELEASE & UTILITY-RELATED ABATEMENT
MEASURE (RAM & URAM) TRANSMITTAL FORM

Release Tracking
Number

1 - 11901

Pursuant to 310 CMR 40.0444 - 0446 and 310 CMR 40.0462 - 0465 (Subpart D)

A. SITE LOCATION:

Site Name: Solutia Inc.
(optional)

Street 730 Worcester Street Location Aid: _____

City/Town: Springfield ZIP 01151-0000
Code: _____

☒ Check here if a Tier Classification Submittal has been provided to DEP for this Release Tracking Number.

Related Release Tracking Numbers That This RAM or URAM
Addresses: _____

B. THIS FORM IS BEING USED TO: (check all that apply)

☒ Submit a **RAM Plan** (complete Sections A, B, C, D, E, F, J, K, L and M).
☐ Check here if this RAM Plan is an update or modification of a previously approved written RAM Plan. Date Submitted: _____

☐ Submit a **RAM Status Report** (complete Sections A, B, C, E, J, K, L and M).

☐ Submit a **RAM Completion Statement** (complete Sections A, B, C, D, E, G, J, K, L and M).

☐ Confirm or Provide **URAM Notification** (complete Sections A, B, H, K, L and M).

☐ Submit a **URAM Status Report** (complete Sections A, B, C, E, J, K, L and M).

☐ Submit a **URAM Completion Statement** (complete Sections A, B, C, D, E, I, J, K, L and M).

You must attach all supporting documentation required for each use of form indicated, including copies of any Legal Notices and Notices to Public Officials required by 310 CMR 40.1400.

C. SITE CONDITIONS:

☒ Check here if the source of the Release or Threat of Release is known.

If yes, check all sources that apply: ☐ UST ☐ Pipe/Hose/Line ☐ AST ☐ Drums ☐ Transformer ☐ Boat

☐ Tanker Truck ☐ Vehicle ☒ Other Specify: Pre-1975 Former above ground process tank

Identify Media and Receptors Affected: (check all that apply) ☐ Air ☒ Groundwater ☐ Surface Water ☐ Sediments ☒ Soil

☐ Wetlands ☐ Storm Drain ☐ Paved Surface ☐ Private Well ☐ Public Water Supply ☐ Zone 2 ☐ Residence

☐ School ☐ Unknown ☐ Other Specify: _____

Identify Release and/or Threat of Release Conditions at Site: (check all that apply)

☐ 2 and 72 Hour Reporting Condition(s) ☒ 120 Day Reporting Condition(s) ☐ Other Condition(s)

Describe Measurement in soil above MCP reportable concentration; no NAPL in
subsurface; not an imminent hazard.

RAMs may be conducted concurrently with an IRA only with written DEP approval
URAMs may not be conducted if any 2 or 72 Hour conditions exist at the site.

Identify Oils and Hazardous Materials Released: (check all that apply) ☐ Oils ☒ Chlorinated Solvents ☐ Heavy Metals

☒ Others Specify: Vinyl chloride-off-spec poly vinyl chloride (PVC)

D. DESCRIPTION OF RESPONSE ACTIONS: (check all that apply)

☐ Assessment and/or Monitoring Only

☐ Excavation of Contaminated Soils

☐ Re-use, Recycling or Treatment

☐ On Site ☐ Off Site Est. Vol.: _____ cubic yards

Describe: _____

☐ Store ☐ On Site ☐ Off Site Est. Vol.: _____ cubic yards

☐ Deployment of Absorbant or Containment Materials

☐ Temporary Covers or Caps

☐ Bioremediation

☒ Soil Vapor Extraction

☐ Structure Venting System

☐ Product or NAPL Recovery

SECTION D IS CONTINUED ON THE NEXT PAGE.



RELEASE & UTILITY-RELATED ABATEMENT
MEASURE (RAM & URAM) TRANSMITTAL FORM

Release Tracking
Number

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Pursuant to 310 CMR 40.0444 - 0446 and 310 CMR 40.0462 - 0465 (Subpart D)

D. DESCRIPTION OF RESPONSE ACTIONS (continued):

- ☐ Landfill ☐ Cover ☐ Disposal Est. Vol.: _____ cubic yards ☐ Groundwater Treatment Systems
- ☐ Removal of Drums, Tanks or Containers ☐ Air Sparging
- Describe _____ ☐ Temporary Water Supplies
- ☐ Removal of Other Contaminated Media ☐ Temporary Evacuation or Relocation of Residents
- Specify Type and Volume: _____ ☐ Fencing and Sign Posting
- ☒ Other Response Actions Describe In-situ chemical oxidation & monitored natural attenuation
- See 310 CMR 40.0442 for limitations on the scope and type of RAMs.
See 310 CMR 40.0464 for performance standards for URAMs.
- ☐ Check here if this RAM or URAM involves the use of Innovative Technologies. DEP is interested in using this information to aid in creating an Innovative Technologies Clearinghouse.
- Describe Technologies: Oxidant degrades vinyl chloride to carbon dioxide and water.

E. TRANSPORT OF REMEDIATION WASTE: (if Remediation Waste has been sent to an off-site facility, answer the following questions)

Name of Facility: _____

Town and State: _____

Quantity of Remediation Waste Transported to Date: None, no remediation wastes

F. RAM PLAN:

- ☐ Check here if this RAM Plan received previous oral approval from DEP as a continuation of a Limited Removal Action (LRA).
- Date of Oral Approval: _____
- ☐ If a RAM Compliance Fee is required, check here to certify that the fee has been submitted. You **MUST** attach a photocopy of the payment. See 310 CMR 40.0444(2) to learn when a fee is not required.
- ☐ Check here if the RAM Plan is proposed for a Transition Site. If this is the case, you may need to attach an LSP Evaluation Opinion prior to undertaking the RAM, if not previously provided. See 310 CMR 40.0600 for further information about Transition Sites.

G. RAM COMPLETION STATEMENT:

- ☐ If a RAM Compliance Fee is required in connection with submission of the RAM Completion Statement, check here to certify that the fee has been submitted. You **MUST** attach a photocopy of the payment. You owe this fee when submitting a RAM Completion Statement if you received oral approval of a RAM that continued an LRA, and have NOT previously submitted a RAM Plan and accompanying fee.
- If any Remediation Waste will be stored, treated, managed, recycled or reused at the site following submission of the RAM Completion Statement, you must submit a Phase IV Remedy Implementation Plan, along with the appropriate transmittal form, as an attachment to the RAM Completion Statement.

H. URAM NOTIFICATION:

- Identify Location Type: (check all that apply) ☐ Public Right of Way ☐ Utility Easement ☐ Private Property
- Identify Utility Type: (check all that apply) ☐ Sanitary/Combined Sewerage ☐ Water ☐ Drainage ☐ Natural Gas
- ☐ Telephone ☐ Steam Lines ☐ Telecommunications ☐ Electric ☐ Other Specify _____
- ☐ Check here if you provided DEP with previous oral notification of this URAM. Date of Oral Notice: _____
- ☐ Check here if the property owner was NOT contacted prior to initiation of the URAM. If this is the case, you must attach an explanation of why the owner was not contacted, including the date and time when contact ultimately occurred.
- ☐ Check here if this URAM will occur in connection with the construction of new public utilities. If this is the case, document the nature and extent of encountered contamination, the scope and expense of necessary mitigation and the benefits and limitations of project alternatives.
- With the exception stated below, the person undertaking the URAM must provide the name and license number of an LSP engaged or employed in connection with the URAM:
- LSP Name: _____ LSP License Number: _____
- LSP information is not required if the URAM is limited to the excavation and/or handling of not more than 100 cubic yards of soil contaminated by Oil, or not more than 20 cubic yards of soil contaminated either by a Hazardous Material or a mixture of a Hazardous Material and Oil.



RELEASE & UTILITY-RELATED ABATEMENT
MEASURE (RAM & URAM) TRANSMITTAL FORM

Release Tracking
Number

1 - 11901

Pursuant to 310 CMR 40.0444 - 0446 and 310 CMR 40.0462 - 0465 (Subpart D)

I. URAM COMPLETION STATEMENT:

☐ Check here if this URAM was limited to the excavation and/or handling of not more than 100 cubic yards of soil contaminated by Oil, or not more than 20 cubic yards of soil contaminated by either a Hazardous Material or a mixture of a Hazardous Material and Oil.

If any Remediation Waste will be stored, treated, managed, recycled or reused at the site following submission of the URAM Completion Statement, you must submit either a Release Abatement Measure (RAM) Plan or a Phase IV Remedy Implementation Plan, along with the appropriate transmittal form, as an attachment to the URAM Completion Statement.

J. LSP OPINION:

I attest under the pains and penalties of perjury that I have personally examined and am familiar with this transmittal form, including any and all documents accompanying this submittal. In my professional opinion and judgment based upon application of (i) the standard of care in 309 CMR 4.02(1), (ii) the applicable provisions of 309 CMR 4.02(2) and (3), and (iii) the provisions of 309 CMR 4.03(5), to the best of my knowledge, information and belief,

> if Section B of this form indicates that a Release Abatement Measure Plan is being submitted, the response action(s) that is (are) the subject of this submittal (i) has (have) been developed in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> if Section B of this form indicates that a Release Abatement Measure Status Report or a Utility-Related Abatement Measure Status Report is being submitted, the response action(s) that is (are) the subject of this submittal (i) is (are) being implemented in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> if Section B of this form indicates that a Release Abatement Measure Completion Statement or a Utility-Related Abatement Measure Completion Statement is being submitted, the response action(s) that is (are) the subject of this submittal (i) has (have) been developed and implemented in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal;

I am aware that significant penalties may result, including, but not limited to, possible fines and imprisonment, if I submit information which I know to be false, inaccurate or materially incomplete.

☐ Check here if the Response Action(s) on which this opinion is based, if any, are (were) subject to any order(s), permit(s) and/or approval(s) issued by DEP or EPA. If the box is checked, you MUST attach a statement identifying the applicable provisions thereof.

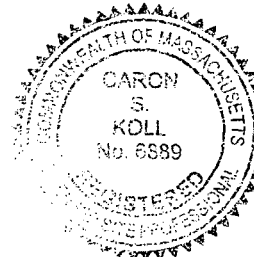
LSP Name: Caron S. Koll LSP #: 6889 Stamp:

Telephone 315-446-2570 Ext.: 148

FAX: 315-449-2353
(optional)

Signature: Caron Koll

Date: 04/12/00



An LSP Opinion is not required for a Utility-Related Abatement Measure Notification.

An LSP Opinion is not required for a URAM Completion Statement if the URAM is limited to the excavation and/or handling of not more than 100 cubic yards of soil contaminated by Oil, or not more than 20 cubic yards of soil contaminated either by Hazardous Material or a mixture of Hazardous Material and Oil.

K. PERSON UNDERTAKING RAM OR URAM:

Name of Organization: Solutia Inc.

Name of Contact: Roy P. Hart Title: Superv., Environmental Protection

Street: 730 Worcester Street

City/Town: Springfield State: MA ZIP Code: 01151-0000

Telephone: 413-730-2682 Ext.: FAX: 413-730-3299
(optional)

☐ Check here if there has been a change in person undertaking the RAM or URAM.



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L. RELATIONSHIP TO SITE OF PERSON UNDERTAKING RAM or URAM: (check one)

- ☒ RP or PRP Specify ☒ Owner ☐ Operator ☐ Generator ☐ Transporter Other RP or PRP: _____
- ☐ Fiduciary, Secured Lender or Municipality with Exempt Status (as defined by M.G.L. c. 21E, s. 2)
- ☐ Agency or Public Utility on a Right of Way (as defined by M.G.L. c. 21E, s. 5(j))
- ☐ Any Other Person Undertaking RAM or URAM Specify Relationship: _____

M. CERTIFICATION OF PERSON UNDERTAKING RAM OR URAM:

I, Roy P Hart, attest under the pains and penalties of perjury (i) that I have personally examined and am familiar with the information contained in this submittal, including any and all documents accompanying this transmittal form, (ii) that, based on my inquiry of those individuals immediately responsible for obtaining the information, the material information contained in this submittal is, to the best of my knowledge and belief, true, accurate and complete, and (iii) that I am fully authorized to make this attestation on behalf of the entity legally responsible for this submittal. I/the person or entity on whose behalf this submittal is made am/is aware that there are significant penalties, including, but not limited to, possible fines and imprisonment, for willfully submitting false, inaccurate, or incomplete information.

By: _____ Title: Superv., Environmental Protection
(signature)

For Solutia Inc. Date: _____
(print name of person or entity recorded in Section K)

Enter address of person providing certification, if different from address recorded in Section K:

Street: _____

City/Town: _____ State: _____ ZIP Code: _____

Telephone: _____ Ext. _____ FAX: _____
(optional)

YOU MUST COMPLETE ALL RELEVANT SECTIONS OF THIS FORM OR DEP MAY RETURN THE DOCUMENT AS INCOMPLETE. IF YOU SUBMIT AN INCOMPLETE FORM, YOU MAY BE PENALIZED FOR MISSING A REQUIRED DEADLINE.